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(11) **EP 0 824 098 B1**

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
31.10.2001 Bulletin 2001/44

(51) Int Cl.7: **C07D 211/48, C07D 211/14,
A61K 31/445**

(21) Application number: **97111742.9**

(22) Date of filing: **10.07.1997**

(54) **4-hydroxy-piperidine derivatives**

4-Hydroxypiperidinderivate

Dérivés de la 4-hydroxypipéridine

(84) Designated Contracting States:
**AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC
NL PT SE**

(30) Priority: **19.07.1996 EP 96111660
01.04.1997 EP 97105366**

(43) Date of publication of application:
18.02.1998 Bulletin 1998/08

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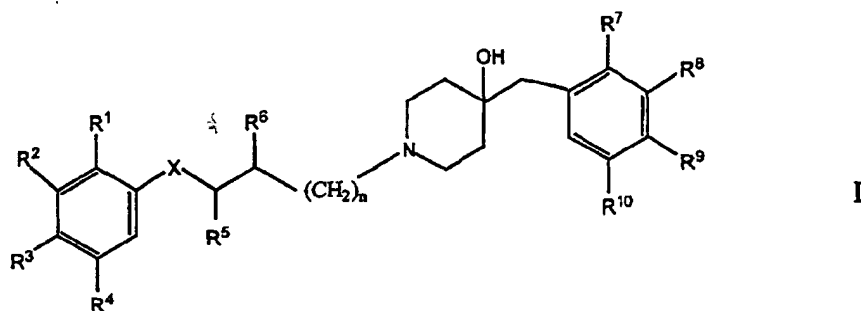
• **JOURNAL OF MEDICINAL CHEMISTRY, vol.34,**
no.10, 1991, COLUMBUS OHIO pages 3085 -
3090, XP000564617 B. L. CHENARD ET AL.
'Separation of alpha 1 Adrenergic and
N-methyl-D-aspartate Antagonist Activity in a
series of Ifenprodil Compounds'

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Description

[0001] The present invention relates to compounds of the general formula



wherein

X is -O-, -NH-, -CH₂-, -CH=, -CO₂-, -CONH-, -CON(lower alkyl)-, -S- and -SO₂-;

R¹-R⁴ are, independently from each other hydrogen, halogen, hydroxy, lower-alkyl-sulfonylamido,

R⁵, R⁶ are, independently from each other hydrogen, lower-alkyl, hydroxy, lower alkoxy or oxo;

R⁷-R¹⁰ are, independently from each other hydrogen, lower-alkyl, halogen, trifluoromethyl or lower-alkoxy;

n is 0 or 1;

and to pharmaceutically acceptable acid addition salts thereof.

[0002] The compounds of formula I and their salts are distinguished by valuable therapeutic properties. Compounds of the present invention are NMDA(N-methyl-D-aspartate)-receptor subtype selective blockers, which have a key function in modulating neuronal activity and plasticity which makes them key players in mediating processes underlying development of CNS as well as learning and memory formation.

[0003] Under pathological conditions of acute and chronic forms of neurodegeneration overactivation of NMDA receptors is a key event for triggering neuronal cell death. NMDA receptors are composed of members from two subunit families, namely NR-1 (8 different splice variants) and NR-2 (A to D) originating from different genes. Members from the two subunit families show a distinct distribution in different brain areas. Heteromeric combinations of NR-1 members with different NR-2 subunits result in NMDA receptors displaying different pharmaceutical properties. Possible therapeutic indications for NMDA receptor subtype specific blockers include acute forms of neurodegeneration caused, e.g., by stroke and brain trauma, and chronic forms of neurodegeneration such as Alzheimer's disease, Parkinson's disease, Huntington's disease, ALS (amyotrophic lateral sclerosis) and neurodegeneration associated with bacterial or viral infections.

[0004] Structurally similar compounds have been described in EP 648 744, FR 2 681 319, FR 2 672 286 and in J. Med. Chem., 1991, 34, 3085-3090, which are 1-substituted 4-benzylpiperidine derivatives.

[0005] Objects of the invention are the compounds of formula I and pharmaceutically acceptable acid addition salts thereof, the preparation of the compounds of formula I and salts thereof, medicaments containing a compound of formula I or a pharmaceutically acceptable acid addition salt thereof, the manufacture of such medicaments and the use of the compounds of formula I and their pharmaceutically acceptable salts in the control or prevention of illnesses, especially of illnesses and disorders of the kind referred to earlier, and, respectively, for the manufacture of corresponding medicaments.

[0006] The following definitions of the general terms used in the present description apply irrespective of whether the terms in question appear alone or in combination.

[0007] As used herein, the term "lower alkyl" denotes a straight- or branched-chain alkyl group containing from 1 to 4 carbon atoms, for example, methyl, ethyl, propyl, isopropyl, butyl and the like.

[0008] The term "halogen" denotes chlorine, iodine, fluorine and bromine.

[0009] The term "lower alkoxy" denotes a group wherein the alkyl residue is as defined above.

[0010] The term "leaving group" has the meaning conventionally used, and refers to, for example, halogen, alkylsul-

fonyloxy, arylsulfonyloxy and the like. The most preferred leaving group in the present case is a halogen.

[0011] The term "pharmaceutically acceptable acid addition salts" embraces salts with inorganic and organic acids, such as hydrochloric acid, nitric acid, sulfuric acid, phosphoric acid, citric acid, formic acid, fumaric acid, maleic acid, acetic acid, succinic acid, tartaric acid, methane-sulfonic acid, p-toluenesulfonic acid and the like.

[0012] The compounds of formula I, in which either R⁵ or R⁶ or both are different from hydrogen and represent a hydroxy or lower alkyl group, contain at least one asymmetric carbon atom. Accordingly, the formation of two diastereomers is possible. The present invention embraces racemic mixtures and their corresponding enantiomers.

[0013] Exemplary preferred compounds in which X denotes O, are:

1-[2-(4-hydroxy-phenoxy)-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 4-(4-fluoro-benzyl)-1-[2-(4-hydroxy-phenoxy)-ethyl]-piperidin-4-ol;
 N-(4-{2-[4-(4-methyl-benzyl)-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide;
 N-(4-{2-[4-(4-fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide;
 N-(4-{2-[4-(4-chloro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide;
 N-(4-{3-[4-(4-fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-propoxy}-phenyl)methanesulfonamide;
 (RS)-1-[2-(4-hydroxy-phenoxy)-1-methyl-ethyl]-4-(4-methyl-benzyl)piperidin-4-ol.

[0014] Exemplary preferred compounds in which X denotes NH, are:

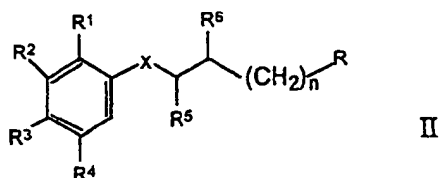
2-(4-benzyl-4-hydroxy-piperidin-1-yl)-N-(4-hydroxy-phenyl)-acetamide;
 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-N-(4-hydroxy-phenyl)acetamide.

[0015] Other exemplary preferred compounds in which X denotes CH₂ are:

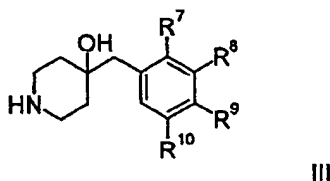
(RS)-4-benzyl-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol;
 (RS)-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-4-(4-methyl-benzyl)piperidin-4-ol;
 (RS)-4-(4-chloro-benzyl)-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol.

[0016] The present compounds of formula I and their pharmaceutically acceptable salts can be prepared by methods known in the art, for example, by processes described below, which comprise

a) reacting a compound of the formula

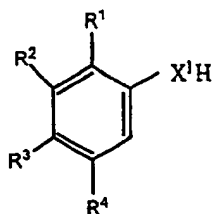


with a compound of the formula



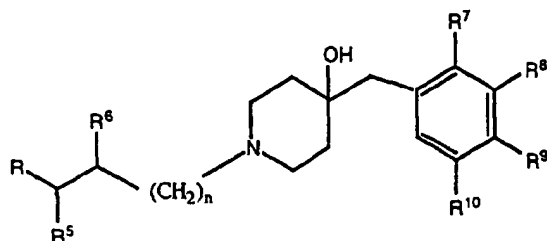
wherein R¹ - R¹⁰ and X have the significances given above, n is 1, R is a leaving group and R⁶ is an oxo- or a hydroxy group, or

b) reacting a compound of the formula



IV

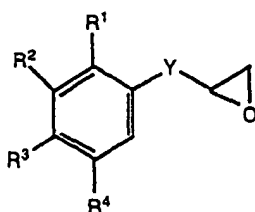
with a compound of the formula



V

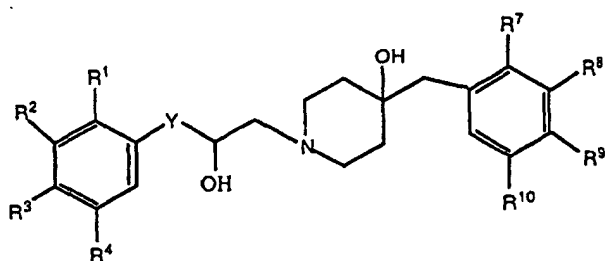
wherein R¹ - R¹⁰, n and R have the significances given above and X¹ is -O-, -NH-, -N- lower alkyl- or -S-, or

c) reacting a compound of the formula



VI

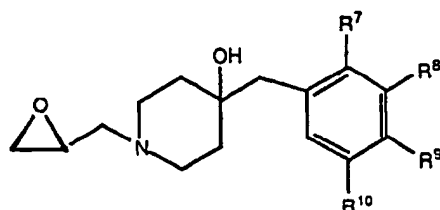
with a compound of the formula III to give a compound of the formula



Ia

wherein R¹ - R⁴ and R⁷ - R¹⁰ have the significances given above, and Y denotes -XCH₂- or -CH₂-, or

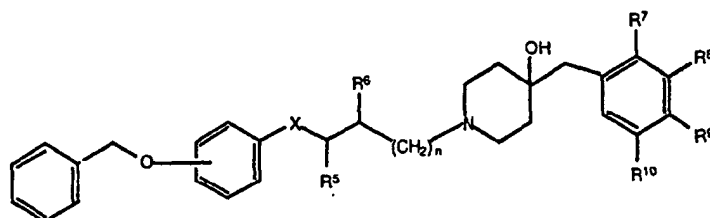
d) reacting a compound of the formula IV with a compound of the formula



VII

to give a compound of the formula Ia, wherein R¹ - R⁴ and R⁷ - R¹⁰ have the significances given above, or

e) debenzylating a compound of the formula



VIII

wherein the substituents are as described above, provided that none of R⁷-R¹⁰ is halogen, or

f) reacting a compound of formula I wherein one of R¹-R⁴ is an amino group with a lower-alkyl-sulfonyl halogen to give a compound of formula I, wherein one of R¹-R⁴ is a lower alkyl-sulfonyl-amino group, or

g) reducing a compound of formula I, wherein R⁵ and/or R⁶ represents a carbonyl group, to yield the corresponding hydroxy compound, or

h) oxidizing a compound of formula I, wherein X represents -S-, to yield the corresponding sulfonyl (-SO₂-) compound, or

i) cleaving off (a) hydroxy or amino protecting group(s) present as (a) substituent(s) R¹-R⁴, and

j) if desired, converting the compound of formula I obtained into a pharmaceutically acceptable acid addition salt.

[0017] In accordance with process variant a) a mixture of a compound of formula III, for example 4-(4-methyl-benzyl)-piperidin-4-ol, and of a compound of formula II, for example, N-[4-(2-bromoethoxy)-phenyl]-methansulfonamide, dissolved in 2-butanone, is refluxed about 12 hours. This reaction is carried out in the presence of a base, for example, potassium carbonate. The compound of formula I is then separated in conventional manner. When one of R¹-R⁴ in formula II is a hydroxy group these groups are protected by groups conventionally used.

[0018] Examples of such groups are described in Green, T., Protective Groups in Organic Synthesis, Chapter 7, John Wiley and Sons, Inc. (1981) pp. 218-287. Most preferred are the benzyloxy, tert-butyl-dimethyl-silyloxy or ethyl-oxycarbonyl groups. This reaction can be carried out by known methods.

[0019] Process variant b) describes a process to obtain compounds of formula I by reaction of a compound of formula IV with a compound of formula V.

[0020] Preferred compounds of formula IV are the corresponding phenoles and amines.

[0021] This reaction is carried out in the presence of a base. Preferred is potassium carbonate. The reaction is refluxed for about 12 hours in a suitable solvent, such as 2-butanone and the yielded compound is then separated in conventional manner.

[0022] In accordance to process variant c) a corresponding oxiranyl-phenyl derivative of formula VI is treated with a compound of formula III to give a corresponding compound of formula Ia. This reaction is carried out in a suitable solvent, such as methanol or ethanol.

[0023] Variant e) describes a process to obtain compounds of formula I, wherein one of R¹-R⁴ is hydroxy. This process is carried out by debenzylating a compound of formula VIII, provided that none of R⁷-R¹⁰ is halogen. The debenzylation

is carried out in conventional manner. For example, a compound of formula VIII is dissolved in a suitable solvent or mixture of solvents, such as ethanol and ethylacetate, and hydrogenated in the presence of Pd on C at room temperature and atmospheric pressure.

[0024] In accordance with process variant f) a compound of formula I can be obtained, wherein one of R¹-R⁴ is a lower-alkyl-sulfonyl-amino group. This reaction is carried out by treating a compound of formula I, wherein one of R¹-R⁴ is an amino group, for example (RS)-1-[3-(4-amino-phenoxy)-2-hydroxy-propyl]-4-benzyl-piperidin-4-ol, with a lower-alkyl-sulfonylhalogen, such as methane sulfonylchloride, in a suitable solvent, such as methylene chloride, in the presence of pyridine at room temperature.

[0025] The process variant g) describes the reduction of a compound of formula I, wherein R⁵ and/or R⁶ represents a carbonyl group to yield the corresponding hydroxy group. This process is carried out in the presence of a metal hydride, such as LiAlH₄, in conventional manner.

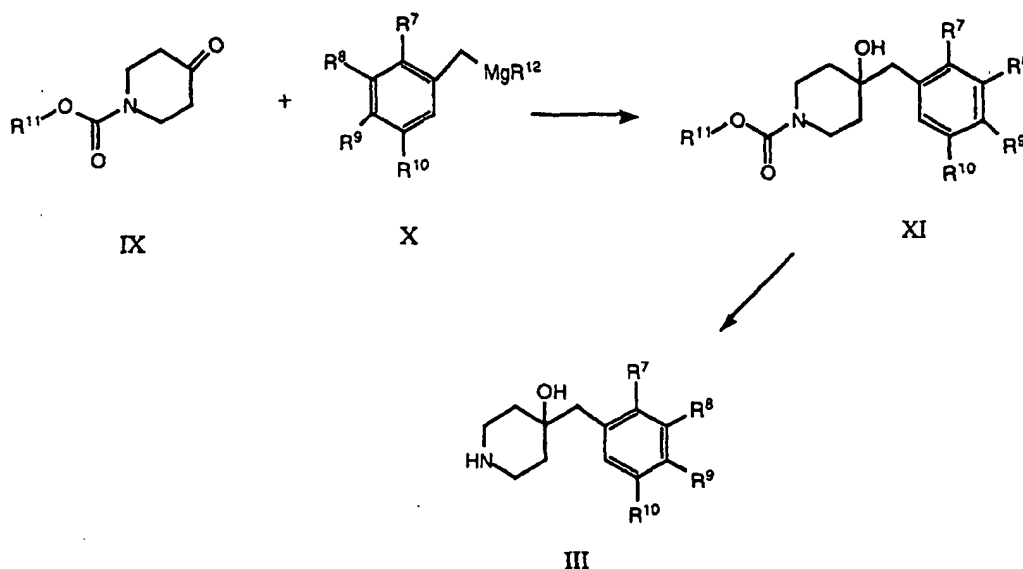
[0026] In accordance with process variant h) a compound of formula I, wherein X represents -S-, is oxidized to yield the corresponding sulfonyl (SO₂-) compound. The oxidation can be carried out in the presence of Oxone® (potassium monopersulfate triple salt) at room temperature.

[0027] Suitable protecting groups and methods for their cleavage will be familiar to any person skilled in the art, although of course there can be used only those protecting group which can be cleaved off by methods under the conditions of which other structural elements in the compounds are not affected.

[0028] The acid addition salts of the compounds of formula I are especially well suited for pharmaceutical use.

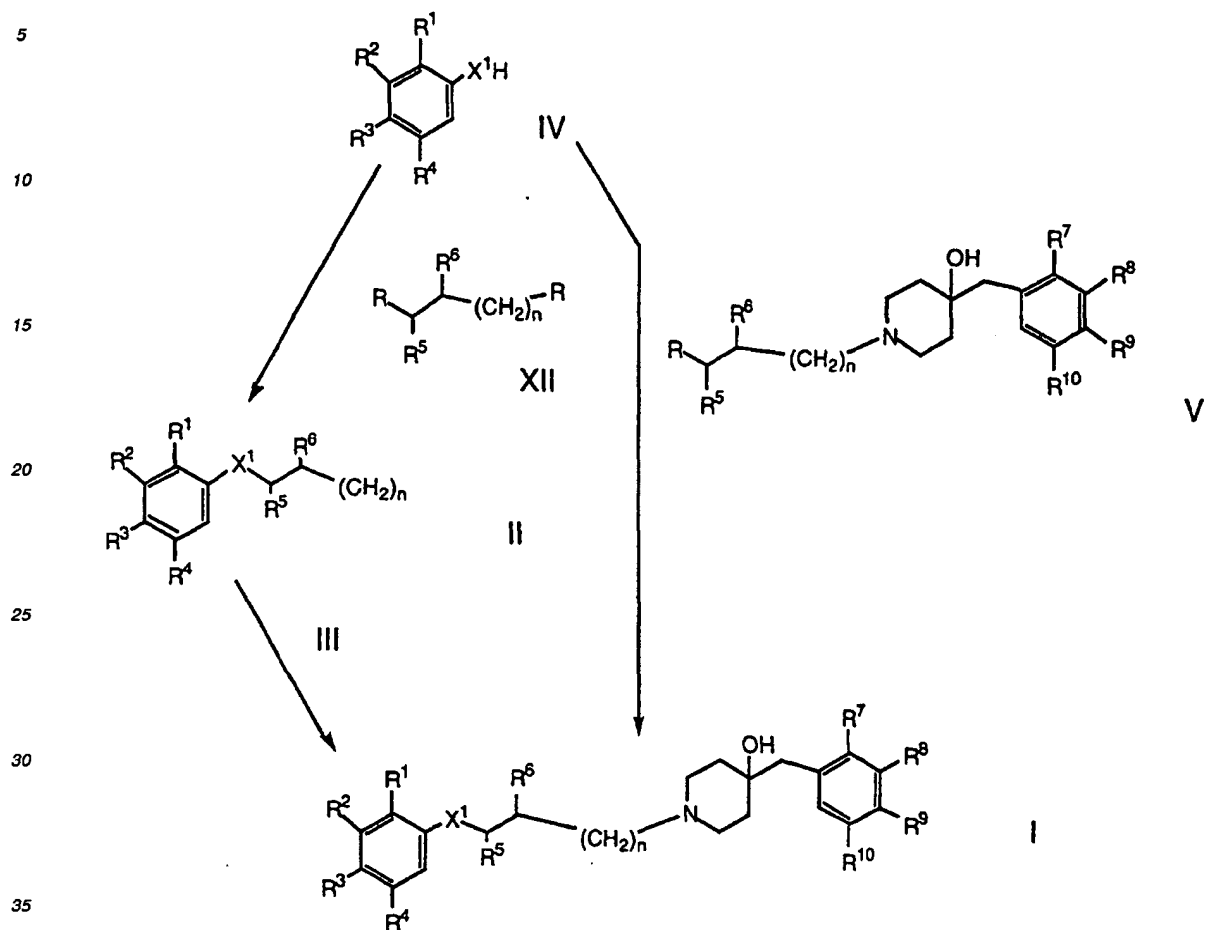
[0029] The starting materials for the preparation of compounds of formula I are known or can be prepared by known methods, for example, according to the following reaction schemes 1-5. These reactions are described in more detail in examples 34-70.

Scheme 1



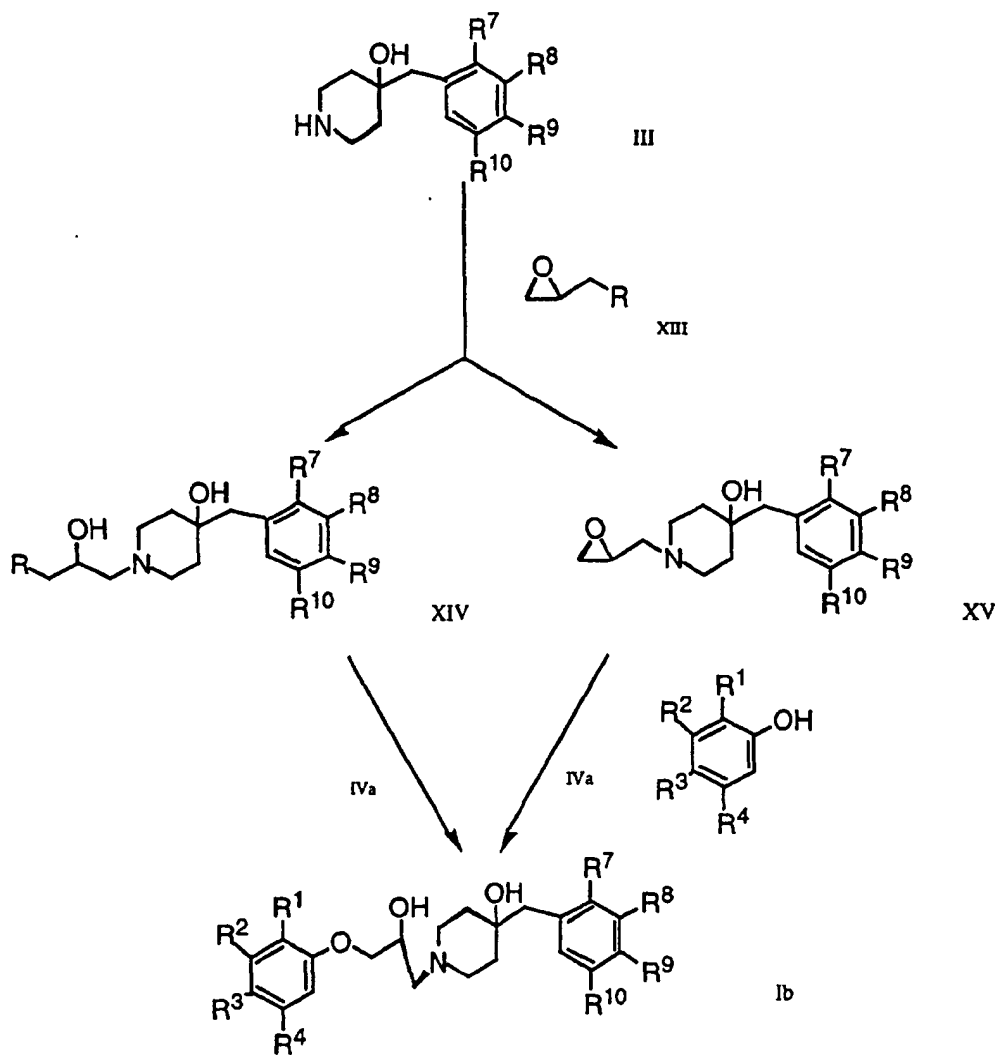
wherein R⁷-R¹⁰ is as above, R¹¹ is lower alkyl, and R¹² is Cl, Br or J.

Scheme 2



wherein R is a leaving group, R¹-R⁵, and R⁷-R¹⁰ have the significances given above, R⁶ is =O or OH, n is 1 and X¹ is -O-, -NH- or -S-.

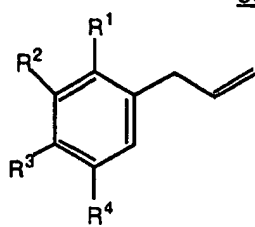
Scheme 3



wherein R, R¹-R⁴ and R⁷-R¹⁰ are described as above.

Schema 4

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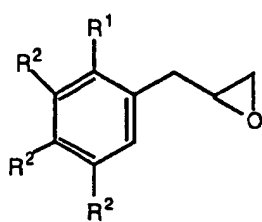
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XVI

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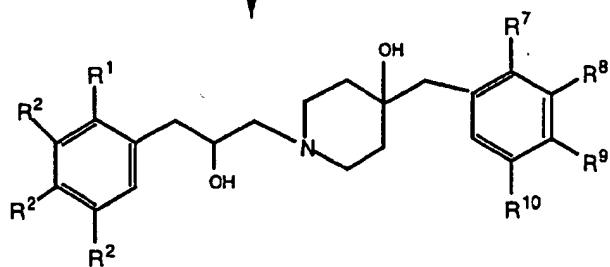
XVII

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III



35



40

Ia1

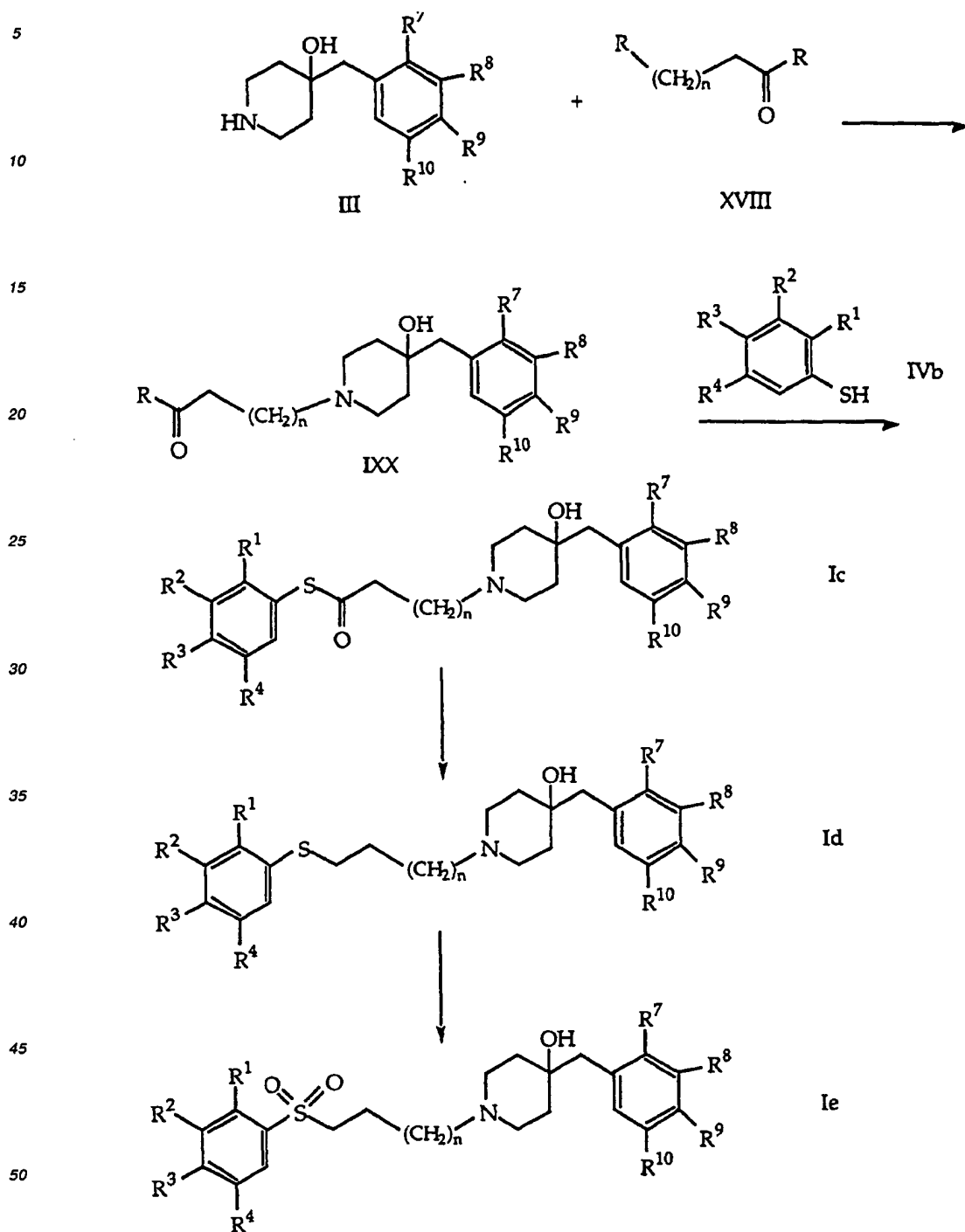
wherein R¹-R⁴, R, n and R⁷-R¹⁰ are described above.

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Scheme 5



wherein R, R¹-R⁴, R⁷-R¹⁰ and n have the significances given above.

[0030] As mentioned earlier, the compounds of formula I and their pharmaceutically usable acid addition salts possess valuable pharmacodynamic properties. They are NMDA-receptor subtype selective blockers, which have a key function in modulating neuronal activity and plasticity which makes them key players in mediating processes underlying

development of CNS as well as learning and memory formation.

[0031] The compounds were investigated in accordance with the tests given hereinafter.

Method 1

3H-Ro 25-6981 binding (Ro 25-6981 is [R-(R*,S*)]-a-(4-Hydroxy-phenyl)-b-methyl-4-(phenyl-methyl)-1-piperidine propanol)

[0032] Male Füllinsdorf albino rats weighing between 150-200 g were used. Membranes were prepared by homogenization of the whole brain minus cerebellum and medulla oblongata with a Polytron (10.000 rpm, 30 seconds), in 25 volumes of a cold Tris-HCl 50 mM, EDTA 10 mM, pH 7.1 buffer. The homogenate was centrifuged at 48.000 g for 10 minutes at 4°C. The pellet was resuspended using the Polytron in the same volume of buffer and the homogenate was incubated at 37°C for 10 minutes. After centrifugation the pellet was homogenized in the same buffer and frozen at -80°C for at least 16 hours but not more than 10 days. For the binding assay the homogenate was thawed at 37°C, centrifuged and the pellet was washed three times as above in a Tris-HCl 5 mM, pH 7.4 cold buffer. The final pellet was resuspended in the same buffer and used at a final concentration of 200 mg of protein/ml.

[0033] 3H-Ro 25-6981 binding experiments were performed using a Tris-HCl 50 mM, pH 7.4 buffer. For displacement experiments 5 nM of 3H-Ro 25-6981 were used and non specific binding was measured using 10 mM of tetrahydroisoquinoline and usually it accounts for 10% of the total. The incubation time was 2 hours at 4°C and the assay was stopped by filtration on Whatmann GF/B glass fiber filters (Unifilter-96, Packard, Zürich, Switzerland). The filters were washed 5 times with cold buffer. The radioactivity on the filter was counted on a Packard Top-count microplate scintillation counter after addition of 40 mL of microscint 40 (Canberra Packard S.A., Zürich, Switzerland).

[0034] The effects of compounds were measured using a minimum of 8 concentrations and repeated at least once. The pooled normalized values were analyzed using a non-linear regression calculation program which provide IC₅₀ with their relative upper and lower 95% confidence limits (RS1, BBN, USA).

Method 2

3H-Prazosine binding

[0035] Male Füllinsdorf albino rats weighing between 150-200 g were used. Membranes were prepared by homogenization of the whole brain minus cerebellum and medulla oblongata with a Plytron (10.000 rpm, 30 seconds), in 25 volumes of a cold Tris-HCl 50 mM, EDTA 10mM, pH 7.1 buffer. The homogenate was centrifuged at 48.000 g for 10 minutes at 4°C. The pellet was resuspended using the Polytron in the same volume of buffer and the homogenate was incubated at 37°C for 10 minutes. After centrifugation the pellet was homogenized in the same buffer and frozen at -80°C for at least 16 hours but not more than 10 days. For the binding assay the homogenate was thawed at 37°C, centrifuged and the pellet was washed three times as above in a Tris-HCl 5mM, pH 7.4 cold buffer. The final pellet was resuspended in the same buffer and used at a final concentration of 200 mg of protein/ml.

[0036] 3H-Prazosine binding experiments were performed using a Tris-HCl 50 mM, pH 7.4 buffer. For displacement experiments 0.2 nM of 3H-Prazosine were used and non specific binding was measured using 100 mM of Chlorpromazine. The incubation time was 30 minutes at room temperature and the assay was stopped by filtration on Whatman GF/B glass fiber filters (Unifilter-96, Canberra Packard S.A., Zürich, Switzerland). The filters were washed 5 times with cold buffer. The radioactivity on the filter was counted on a Packard Top-count microplate scintillation counter after addition of 40 ml of microscint 40 (Canberra Packard S.A., Zürich, Switzerland). The effects of compounds were measured using a minimum of 8 concentrations and repeated at least once. The pooled normalized values were analyzed using a non-linear regression calculation program which provide IC₅₀ with their relative upper and lower 95% confidence limits (RS1, BBN, USA).

Method 3

Electrophysiology on recombinant NMDA receptors

[0037] cDNA clones coding for the subunits NMDAR1C and NMDAR2A of the NMDA receptor (see Hollmann and Heinemann, 1994, Annu. Rev. Neurosci. 17:31 for nomenclature of NMDA receptor subunits) were isolated from a rat brain lgt11 cDNA library as published elsewhere (Sigel et al., 1994, J. Biol. Chem. 269:8204). The clone for the subunit NMDAR2B of the rat brain NMDA receptor was obtained from S. Nakanishi (Kyoto, Japan). The cDNAs were transcribed, capped and poly(A⁺)-tailed as described previously (Malherbe et al., 1990, Mol. Brain Res. 8: 199). Oocytes of South African frogs (*Xenopus laevis*) were used for expressing either a combination of the NMDAR1C and NMDAR2A

subunits or the NMDAR1C and NMDAR2B subunits. Approximately 3 fmol of a 1:1 mixture of the respective mRNA species were injected into every oocyte. Four to five days later the ion current through the NMDA receptor channels was measured in voltage clamp experiments (see Methfessel et al., 1986, Pflügers Arch. 407:577 for the methods of oocyte expression and voltage-clamping). The membrane potential was clamped to -80 mV and the receptors were activated by applying a modified Ringer's solution containing the NMDA-receptor agonists L-aspartate (Asp) and glycine (Gly). Different agonist concentrations were chosen for either subunit combination to account for the different agonist sensitivities of the two types of receptors (70 mM Asp plus 2.5 mM Gly for NMDAR1C - NMDAR2A and 15 mM Asp plus 0.2 mM Gly for NMDAR1C - NMDAR2B). The agonists were applied for 15 s intervals once every 2.5 min by rapid superfusion of the oocyte with agonist containing solution and the amplitude of the agonist-evoked current was measured immediately before the end of each application. After a series of initial control applications the antagonist to be tested was added to both, the basal Ringer's and the agonist containing solution. The antagonist concentration applied to oocytes expressing the NR2A subunit was 10 mmol/l, whereas 0.1 mmol/l were applied to the NR2B expressing oocytes. Four to eight oocytes were tested for every compound and NMDA receptor subtype. Oocytes were exposed to the compounds for 5 to 30 min depending on the time needed for reaching an equilibrium block of the NMDA receptor current. For every oocyte the decrease of the current amplitude was expressed as a percentage of the control current measured before application of the compound. Figures in the table are arithmetic mean values of these percentage values. The thus-determined activity of some compounds in accordance with the invention will be evident from the following table.

Table 1

Compound/ Example	3H-Ro 25-6981 binding IC ₅₀ (mM)	3H- prazosine binding IC ₅₀ (mM)	Electrophysiology, % block by	
			10 mM NR1C+NR2A	0.1 mM NR1C+NR2B
A/1	0.015	1.5	29	90
B/5	0.060	4.0		
C/8	0.010	3.5	31	88
D/9	0.040	3.0		
E/10	0.030	5.0	27	91
F/11	0.060	6.0		
G/12	0.030	9.0		
H/13	0.040	1.8		
I/16	0.040	2.5		
J/17	0.070	20.0		
K/21	0.040	30.0	10	83
L/27	0.060	7.4		
M/28	0.020	9.7	10	89
N/29	0.040	9.2	19	81
O/31	0.010	0.8		
P/32	0.003	0.26		
Q/33	0.010	5.0		
R/34	0.006	5.3	8	42
S/35	0.016	7.3		
T/36	0.009	2.3		
V/38	0.008	3.0		

[0038] In this Table the respective compounds are:

- A (RS)-1-[2-Hydroxy-3-(4-hydroxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 B (S)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol;
 C 1-[2-(4-Hydroxy-phenoxy)-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 D 4-(4-Fluoro-benzyl)-1-[2-(4-hydroxy-phenoxy)-ethyl]-piperidin-4-ol;
 5 E N-(4-{2-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethoxy}-phenyl)-methanesulfonamide;
 F N-(4-{2-[4-(4-Fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)-methanesulfonamide;
 G N-(4-{2-[4-(4-Chloro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)-methanesulfonamide;
 H N-(4-{3-[4-(4-Fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-propoxy}-phenyl)-methanesulfonamide;
 I 1-[2-(4-Hydroxy-phenoxy)-1-methyl-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 10 J 2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-(4-hydroxy-phenyl)-acetamide;
 K 2-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-N-(4-hydroxy-phenyl)-acetamide;
 L (RS)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol;
 M (RS)-1-[2-Hydroxy-3-(4-hydroxy-phenyl)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 N (RS)-4-(4-Chloro-benzyl)-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol;
 15 O 4-Hydroxy-benzoic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl] ethylester;
 P 4-Hydroxy-benzoic acid 3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propylester;
 Q N-[2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-ethyl]-4-hydroxy-benzamide;
 R 4-Hydroxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-benzamide;
 S N-[3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-propyl]-4-hydroxy-benzamide;
 20 T 4-Hydroxy-N-[3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl]-benzamide;
 V (E)-1-[3-(4-Hydroxy-phenyl)-allyl]-4-(4-methyl-benzyl)-piperidin-4-ol

[0039] By screening compounds of formula I could be identified as NMDA receptor subtype selective blockers and - for selected compounds - the preference for NMDAR-2B subunits could be demonstrated by electrophysiological characterization using cloned NMDA receptor subtypes expressed oocytes.

[0040] The compounds of formula I and their salts, as herein described, can be incorporated into standard pharmaceutical dosage forms, for example, for oral or parenteral application with the usual pharmaceutical adjuvant materials, for example, organic or inorganic inert carrier materials, such as, water, gelatin, lactose, starch, magnesium stearate, talc, vegetable oils, gums, polyalkylene-glycols and the like. The pharmaceutical preparations can be employed in a solid form, for example, as tablets, suppositories, capsules, or in liquid form, for example, as solutions, suspensions or emulsions. Pharmaceutical adjuvant materials can be added and include preservatives stabilizers, wetting or emulsifying agents, salts to change the osmotic pressure or to act as buffers. The pharmaceutical preparations can also contain other therapeutically active substances.

[0041] The daily dose of compounds of formula I to be administered varies with the particular compound employed, the chosen route of administration and the recipient. Representative of a method for administering the compounds of formula I is by the oral and parenteral type administration route. An oral formulation of a compound of formula I is preferably administered to an adult at a dose in the range of 150 mg to 1.5 g per day. A parenteral formulation of a compound of formula I is preferably administered to an adult at a dose in the range of 5 to 500 mg per day.

[0042] The following Examples illustrate the invention in more detail. All temperatures are given in degrees Celsius.

Example 1

(RS)-1-[2-Hydroxy-3-(4-hydroxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol hydrochloride

[0043] (RS)-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-4-(4-methyl-benzyl)piperidin-4-ol (0.75 g, 1.6 mmol) was dissolved in a mixture of ethanol (20 ml) and ethyl acetate (20 ml) and hydrogenated in the presence of Pd on C at room temperature and atmospheric pressure. After filtration and evaporation of the solvent the residue was dissolved in ethanol (30 ml) and ethyl acetate (20 ml). 1.1 Equivalent of ethanolic HCl were added to give (RS)-1-[2-hydroxy-3-(4-hydroxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol hydrochloride (0.38 g, 58%) as colourless solid mixture of the E/Z isomers, m.p. 93-96°C and MS: m/e = 372.5 (M+H⁺).

[0044] Following the general method of Example 1 the compounds of Example 2 to Example 5 were prepared.

Example 2

(RS)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride

[0045] The title compound, m.p. 89-91°C and MS: m/e = 358.4 (M+H⁺), was prepared from (RS)-4-benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-piperidin-4-ol.

Exempl 3(RS)-4-(4-Fluoro-benzyl)-1-[2-hydroxy-3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride

- 5 **[0046]** The title compound, m.p. 199-202°C and MS: m/e = 376.4 (M+H⁺), was prepared from (RS)-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-4-(4-fluorobenzyl)-piperidin-4-ol.

Example 4

10 (R)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride

[0047] The title compound, m.p. 77-80°C, $[\alpha]_{365}^{20} = +48.8^\circ$ (c = 1.0, methanol) and MS: m/e = 358.5 (M+H⁺), was prepared from from (R)-4-benzyl-1-[3-(4-benzyloxyphenoxy)-2-hydroxy-propyl]-piperidin-4-ol.

Example 5(S)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride

- 20 **[0048]** The title compound, m.p. 122-125°C, $[\alpha]_{365}^{20} = -48.0^\circ$ (c = 1.0, methanol) and MS: m/e = 358.5 (M+H⁺), was prepared from from (S)-4-benzyl-1-[3-(4-benzyloxyphenoxy)-2-hydroxy-propyl]-piperidin-4-ol.

Example 6(RS)-N-{4-[3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-2-hydroxy-propoxy]-phenyl}methanesulfonamide hydrochloride

- 25 **[0049]** Methane sulfonylchloride (0.105 ml, 1.4 mmol) was added to a suspension of (RS)-1-[3-(4-amino-phenoxy)-2-hydroxy-propyl]-4-benzyl-piperidin-4-ol hydrochloride (0.5 g, 1.3 mmol) in CH₂Cl₂ (10 ml) and pyridine (5 ml) at room temperature. The mixture was stirred at room temperature overnight, water (15 ml) and brine (15 ml) were added and the mixture was extracted with CH₂Cl₂ (5x25 ml). The organic phases were pooled, dried with Na₂SO₄ and the solvent
30 evaporated. The residue was chromatographed over silica gel (ethyl acetate-MeOH, 96:4) to give a colourless oil which was dissolved in ethanol (2 ml). 1.1 Equivalent of ethanolic HCl and *t*-butylmethylether (50 ml) were added to give (RS)-N-{4-[3-(4-benzyl-4-hydroxy-piperidin-1-yl)-2-hydroxy-propoxy]-phenyl}-methanesulfonamide hydrochloride (0.24 g, 38%) as colourless solid mixture of the E/Z isomers, m.p. > 230°C dec and MS: m/e = 435.4 (M+H⁺).

Example 74-Benzyl-1-[2-(4-hydroxy-phenoxy)-ethyl]-piperidin-4-ol hydrochloride

- 40 **[0050]** 4-Benzyl-1-[2-(4-benzyloxy-phenoxy)-ethyl]-piperidin-4-ol (1.35 g, 3.2 mmol) was dissolved in a mixture of MeOH (75 ml) and ethyl acetate (75 ml) and hydrogenated in the presence of Pd on C at room temperature and atmospheric pressure. After filtration and evaporation of the solvent the residue was dissolved in ethanol (2 ml) and ethyl acetate (10 ml). 1.1 equivalent of ethanolic HCl were added to give 4-benzyl-1-[2-(4-hydroxy-phenoxy)-ethyl]-piperidin-4-ol hydrochloride (0.85 g, 72%) as colourless solid, m.p. 161-163°C and MS: m/e = 328.3 (M+H⁺).
45 **[0051]** Following the general method of Example 7 the compounds of Example 8 to Example 9 were prepared.

Example 81-[2-(4-Hydroxy-phenoxy)-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol fumarate (1:0.5)

- 50 **[0052]** The title compound, m.p. 216-218°C and MS: m/e = 341 (M⁺), was prepared from 1-[2-(4-benzyloxy-phenoxy)-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol.

Example 9

55 4-(4-Fluoro-benzyl)-1-[2-(4-hydroxy-phenoxy)-ethyl]-piperidin-4-ol hydrochloride

[0053] The title compound, m.p. 153-155°C and MS: m/e = 345 (M⁺), was prepared from 1-[2-(4-benzyloxy-phenoxy)-ethyl]-4-(4-fluoro-benzyl)-piperidin-4-ol.

Example 10N-(4-{2-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide hydrochloride

5 **[0054]** A mixture of 4-(4-methyl-benzyl)-piperidin-4-ol (0.35 g, 1.7 mmol), N-[4-(2-bromethoxy)-phenyl]-methanesulfonamide (0.5 g, 1.7 mmol) and potassium carbonate (0.25 g, 1.8 mmol) in 2-butanone (20 ml) was refluxed overnight. It was cooled to room temperature, 30 ml of H₂O were added and the organic phase was separated. The water phase was extracted two times with ethyl acetate. The organic phases were then pooled, dried with Na₂SO₄ and the solvent
 10 was evaporated. The residue was chromatographed over silica gel (CH₂Cl₂-MeOH, 95:5) to give a yellowish foam which was dissolved in ethanol (5 ml) and ethyl acetate (10 ml). 1.1 Equivalent of ethanolic HCl were added to give N-(4-{2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide hydrochloride (0.32 g, 41%) as colourless solid, m.p. > 75-78°C dec. and MS: m/e = 419.5 (M+H⁺).

[0055] Following the general method of Example 10 the compounds of Example 11 to Example 13 were prepared.

Example 11N-(4-{2-[4-(4-Fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide hydrochloride

20 **[0056]** The title compound, m.p. 131-134°C and MS: m/e = 423.4 (M+H⁺), was prepared from 4-(4-fluoro-benzyl)-piperidin-4-ol and N-[4-(2-bromethoxy)-phenyl]methanesulfonamide.

Example 1213N-(4-{2-[4-(4-Chloro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)methanesulfonamide hydrochloride

25 **[0057]** The title compound, m.p. 74-77°C and MS: m/e = 439.4 (M+H⁺), was prepared from 4-(4-chloro-benzyl)-piperidin-4-ol and N-[4-(2-bromoethoxy)-phenyl]methanesulfonamide.

Example 13N-(4-{3-[4-(4-fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-propoxy}-phenyl)methanesulfonamide hydrochloride

30 **[0058]** The title compound MS: m/e = 437.4 (M+H⁺), was prepared from 4-(4-fluorobenzyl)-piperidin-4-ol and N-[4-(2-bromopropoxy)-phenyl]-methanesulfonamide.

Example 144-Benzyl-1-[3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride

40 **[0059]** 4-Benzyl-1-[3-(4-benzyloxy-phenoxy)-propyl]-piperidin-4-ol (0.432 g, 1 mmol) was dissolved in MeOH (50 ml) and hydrogenated in the presence of Pd on C at room temperature and atmospheric pressure. After filtration and evaporation of the solvent the residue was dissolved in THF (3 ml) and ether (10 ml). 1.1 equivalent of etheric HCl were added to give 4-benzyl-1-[3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride (0.30 g, 88%) as colourless solid, m.p. 64°C and MS: m/e = 342.3 (M+H⁺).

45 **[0060]** Following the general method of Example 14 the compounds of Example 15 to Example 19 were prepared.

Example 154-(4-Fluoro-benzyl)-1-[3-(4-hydroxy-phenoxy)-propyl]-piperidin-4-ol hydrochloride

50 **[0061]** The title compound, MS: m/e = 360.4 (M+H⁺), was prepared from 1-[3-(4-benzyloxy-phenoxy)-propyl]-4-(4-fluoro-benzyl)-piperidin-4-ol.

Example 161-[3-(3-Hydroxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol hydrochloride

55 **[0062]** The title compound, MS: m/e = 356.4 (M+H⁺), was prepared from 1-[3-(3-benzyloxy-phenoxy)-propyl]-4-

(4-methyl-benzyl)-piperidin-4-ol.

Example 17

5 1-[3-(2-Hydroxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol hydrochloride

[0063] The title compound, MS: m/e = 356.4 (M+H⁺), was prepared from 1-[3-(2-benzyloxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol.

10 Example 18

1-[2-(4-Hydroxy-phenoxy)-ethyl]-4-(4-methoxy-benzyl)-piperidin-4-ol hydrochloride

15 [0064] The title compound, MS: m/e = 358.3 (M+H⁺), was prepared from 1-[2-(4-benzyloxy-phenoxy)-ethyl]-4-(4-methoxy-benzyl)-piperidin-4-ol

Example 19

20 1-[2-(4-Hydroxy-phenoxy)-1-methyl-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol hydrochloride

[0065] The title compound, MS: m/e = 356.3 (M+H⁺), was prepared from 1-[2-(4-benzyloxy-phenoxy)-1-methyl-ethyl]-4-(4-methoxy-benzyl)-piperidin-4-ol

Example 20

25

2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-(4-hydroxy-phenyl)-acetamide hydrochloride

[0066] 2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)phenyl]-acetamide (0.454 g, 1 mmol) was dissolved in THF (6 ml) and stirred for 18 hours at room temperature in the presence of tetra-n-butylammonium fluoride/SiO₂ (1g, 1.1 mmol, 1.1 mmol/g). The reaction mixture was quenched with 20% NH₄Cl (20 ml) and the aqueous phase was extracted with ethyl acetate (3x5ml). Combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexan-ethyl acetate 1:1 then ethyl acetate) to give a foam which was dissolved in MeOH and treated with 1N HCl (0.9 ml). The solution was concentrated and the residue was refluxed in the presence of acetonitrile for 2 hours to provide after cooling 2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-(4-hydroxy-phenyl)-acetamide-hydrochloride (0.27 g, 72%) as colourless solid mixture of the E/Z isomers, m.p. 222-225°C and MS: m/e = 341.5 (M+H⁺).

[0067] Following the general method of Example 20 the compounds of Example 21 to Example 24 were prepared.

Example 21

40

2-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-N-(4-hydroxy-phenyl)-acetamide hydrochloride

[0068] The title compound, m.p. 242-243°C and MS: m/e = 355.4 (M+H⁺), was prepared from N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-acetamide.

45

Example 22

2-[4-(4-Chloro-benzyl)-4-hydroxy-piperidin-1-yl]-N-(4-hydroxy-phenyl)-acetamide hydrochloride

50 [0069] The title compound, m.p. 205-210°C and MS: m/e = 375.3 (M+H⁺), was prepared from N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-[4-(4-chloro-benzyl)-4-hydroxy-piperidin-1-yl]-acetamide

Example 23

55

2-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-N-(4-hydroxy-phenyl)propionamide hydrochloride

[0070] The title compound, m.p. 257°C and MS: m/e = 369.3 (M+H⁺), was prepared from N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propionamide

Exempl 243-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-(4-hydroxy-phenyl)-propionamide hydrochloride

- 5 **[0071]** The title compound, m.p. 140-145°C and MS: m/e = 355.4 (M+H⁺), was prepared from 3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-propionamide

Example 2510 4-Benzyl-1-[2-(4-hydroxy-phenylamino)-ethyl]-piperidin-4-ol hydrochloride

- [0072]** A solution of 2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-acetamide (0.97g, 2.13 mmol) in THF (5 ml) was added dropwise to a room temperature suspension of LiAlH₄ (0.162 g, 4.26 mmol) in THF (5 ml). After 20 hours at room temperature, the reaction mixture was refluxed during 3 hours. The reaction mixture was cooled to 0°C, and treated successively with H₂O (0.2 ml), 5N NaOH (0.2 ml) and H₂O (0.6 ml). After evaporation of THF, the resulting solid was filtered and washed with CH₂Cl₂. The aqueous phase was extracted with CH₂Cl₂ (3x 10 ml), the combined organic phases were dried over Na₂SO₄ and concentrated. The residue was dissolved with CH₂Cl₂ (5ml) and stirred in the presence of tetra-n-butylammonium fluoride/SiO₂ (0.5g, 0.55 mmol, 1.1 mmol/g). After 4 hours at room temperature, the reaction mixture was quenched with 20% NH₄Cl (15 ml) and the aqueous phase was extracted with CH₂Cl₂ (2x5ml). Combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (CH₂Cl₂-MeOH 9:1 then 4:1) to give a foam which was dissolved in MeOH and treated with 1N HCl (0.6 ml). The solution was concentrated and the residue was dissolved with EtOH. Addition of ether provided 4-Benzyl-1-[2-(4-hydroxy-phenylamino)ethyl]-piperidin-4-ol hydrochloride (0.045 g, 5.3 %) as beige solid, m.p. 130-140°C and MS: m/e = 327.4 (M+H⁺).

Example 264-Benzyl-1-[3-(4-hydroxy-phenylamino)-propyl]-piperidin-4-ol hydrochloride

- 30 **[0073]** A solution of 3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-propionamide (0.71g, 1.51 mmol) in THF (4 ml) was added dropwise to a 0°C suspension of LiAlH₄ (0.115 g, 3.02 mmol) in THF (4 ml). The reaction mixture was refluxed during 30 min, cooled to 0°C and quenched carefully with H₂O (5 ml). After dilution with H₂O (20 ml), the reaction mixture was treated successively with 2N HCl and sat. NaHCO₃. The aqueous phase was extracted with CH₂Cl₂ (3x 10 ml), the combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (CH₂Cl₂-MeOH 9:1 then 4:1) to give a foam which was dissolved in MeOH and treated with excess HCl/ether. The solution was concentrated and the residue was dissolved with EtOH. Addition of ether provided 4-Benzyl-1-[3-(4-hydroxy-phenylamino)-propyl]piperidin-4-ol hydrochloride (0.160 g, 26 %) as beige solid, m.p. 213-216°C and MS: m/e = 341.5 (M+H⁺).

Example 27(RS)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol hydrochloride

- 45 **[0074]** (RS)-4-Oxiranylmethyl-phenol (0.12 g, 0.8 mmol) was dissolved in MeOH (3 ml) and refluxed for 3 hours in the presence of 4-Benzyl-4-hydroxy-piperidin (0.19 g, 1.0 mmol). Reaction mixture was concentrated and the residue was chromatographed over silica gel (CH₂Cl₂-MeOH 19:1 then 9:1 then 4:1) to give a white foam which was dissolved in MeOH (3 ml) and treated with 1N HCl (0.5 ml). The solution was concentrated and the residue was dissolved in MeOH (2 ml). Addition of ether provided (RS)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol hydrochloride (0.112 g, 37%) as white solid mixture of the E/Z isomers, m.p. 135-136°C and MS: m/e = 341 (M⁺).
- 50 **[0075]** Following the general method of Example 27 the compounds of Example 28 to Example 29 were prepared.

Example 28(RS)-1-[2-Hydroxy-3-(4-hydroxy-phenyl)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol hydrochloride

- 55 **[0076]** The title compound, m.p. 196-197°C and MS: m/e = 355 (M⁺), was prepared from (RS)-4-Oxiranylmethyl-phenol and 4-(4-Methyl-benzyl)-piperidin-4-ol.

Example 29(RS)-4-(4-Chloro-benzyl)-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol hydrochloride

- 5 **[0077]** The title compound, m.p. 172-174°C and MS: m/e = 376.4 (M+H⁺), was prepared from (RS)-4-Oxiranylmethyl-phenol and 4-(4-Chloro-benzyl)-piperidin-4-ol.

Example 30

10 1-(4-Benzyl-4-hydroxy-piperidin-1-yl)-3-(4-hydroxy-phenyl)-propan-2-one hydrochloride

- [0078]** 1-(4-Benzyl-4-hydroxy-piperidin-1-yl)-3-[4-(tert-butyl-dimethyl-silanyloxy)phenyl]-propan-2-one (0.400 g, 0.88 mmol) was dissolved in THF (4 ml) and stirred for 16 hours at room temperature in the presence of 1N tetra-n-butylammonium fluoride (1ml, 1 mmol). The reaction mixture was quenched with 20% NH₄Cl (15 ml) and the aqueous
 15 phase was extracted with ethyl acetate (3x20ml). Combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (ethyl acetate) to give a yellow oil which was dissolved in MeOH (2 ml) and treated with 1N HCl (0.5 ml). The solution was concentrated, the residue was dissolved in i-PrOH and ether was added to provide 1-(4-Benzyl-4-hydroxy-piperidin-1-yl)-3-(4-hydroxy-phenyl)-propan-2-one hydrochloride (0.120 g, 36%) as white solid, m.p. 180-181°C and MS: m/e = 340.3 (M+H⁺).

Example 314-Hydroxy-benzoic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl] ethylester hydrochloride (1:1)

- 25 **[0079]** 4-Benzyloxy-benzoic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl ester (0.63 g, 1.37 mmol) was dissolved in THF (12 ml) and refluxed 8 hours in the presence of Pd/C (10%) (31 mg) under an atmospheric pressure of hydrogen. After filtration of the catalyst and evaporation of the solvent, the residue was crystallized in the presence of ethylacetate (15 ml). The white solid was dissolved in THF (10 ml) and a saturated solution of HCl in ether
 30 was added to provide 4-hydroxy-benzoic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl] ethylester hydrochloride (0.2 g, 37%) as a colourless solid mixture of the E/Z isomers, m.p. 151-152°C and MS: m/e=370.3 (M+H⁺).
[0080] Following the general method of Example 31 the compound of Example 32 was prepared.

Example 32

35 4-Hydroxy-benzoic acid 3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propylester hydrochloride (1:1)

- [0081]** The title compound, m.p. 178-179°C and MS: m/e=384.3 (M+H⁺) was prepared from 4-benzyloxy-benzoic acid 3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl ester.

Example 33N-[2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-ethyl]-4-hydroxy-benzamide

- 45 **[0082]** Palladium on carbon (10%, 150 mg) was added to a solution of 4-benzyloxy-N-[2-(4-hydroxy-4-phenyl-piperidin-1-yl)-ethyl]-benzamide (500 mg, 1.12 mmol) in acetic acid (20 ml). The hydrogenation was complete after 3 h. The catalyst was removed by filtration through celite and the solvent was evaporated. Addition of sodium bicarbonate (10% aq. solution, 2 ml) and extraction with dichloromethane afforded N-[2-(4-benzyl-4-hydroxy-piperidin-1-yl)-ethyl]-4-hydroxy-benzamide (399 mg, 95%) as a light yellow solid.

Example 344-Hydroxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-benzamide hydrochloride (1:1)

- 55 **[0083]** Palladium on carbon (10%, 145 mg) was added to a solution of 4-benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-benzamide (780 mg, 1.7 mmol) in acetic acid (20 ml). The hydrogenation was complete after 4 h. The catalyst was removed by filtration through celite and the solvent was evaporated. Sodium bicarbonate (10% aq. solution, 2 ml) was added, and the aqueous layer extracted with dichloromethane. The organic layer was dried (Na₂SO₄), filtered and evaporated. The residue was dissolved in dichloromethane (3 ml) and saturated HCl in ether

was added. The precipitate was filtered to give 4-benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]benzamide hydrochloride (1:1) (460 mg, 67%) as a white solid. MS: $m/e = 369$ (M+H)⁺.

Example 35

N-[3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-propyl]-4-hydroxy-benzamide

[0084] Palladium on carbon (10%, 50 mg) was added to a solution of N-[3-(4-benzyl-4-hydroxy-piperidin-1-yl)-propyl]-4-benzyloxy-benzamide (185 mg, 0.40 mmol) in acetic acid (5 ml). The hydrogenation was complete after 4 h. The catalyst was removed by filtration through celite and the solvent was evaporated. Sodium bicarbonate (10% aq. solution, 2 ml) was added, and the aqueous layer extracted with dichloromethane. The organic layer was dried (Na₂SO₄), filtered and evaporated to give N-[3-(4-benzyl-4-hydroxy-piperidin-1-yl)propyl]-4-hydroxy-benzamide (130 mg, 87%) as a white solid. MS: $m/e = 369$ (M+H)⁺.

Example 36

4-Hydroxy-N-[3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl]-benzamide

[0085] Palladium on carbon (10%, 50 mg) was added to a solution of 4-benzyloxy-N-[3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl]-benzamide (220 mg, 0.46 mmol) in acetic acid (5 ml). The hydrogenation was complete after 4 h. The catalyst was removed by filtration through celite and the solvent was evaporated. Sodium bicarbonate (10% aq. solution, 2 ml) was added, and the aqueous layer extracted with dichloromethane. The organic layer was dried (Na₂SO₄), filtered and evaporated to give 4-hydroxy-N-[3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl]-benzamide (178 mg, 73%) as a white solid. MS: $m/e = 383$ (M+H)⁺.

Example 37

4-Hydroxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-N-methyl-benzamide

[0086] Palladium on carbon (10%, 60 mg) was added to a solution of 4-benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-N-methyl-benzamide (226 mg, 0.48 mmol) in acetic acid (6 ml). The hydrogenation was complete after 4 h. The catalyst was removed by filtration through celite and the solvent was evaporated. Sodium bicarbonate (10% aq. solution, 2 ml) was added, and the aqueous layer extracted with dichloromethane. The organic layer was dried (Na₂SO₄), filtered and to give 4-hydroxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-N-methyl-benzamide (135 mg, 74%) as a white solid. MS: $m/e = 383$ (M+H)⁺.

Example 38

(E)-1-[3-(4-Hydroxy-phenyl)-allyl]-4-(4-methyl-benzyl)-piperidin-4-ol

[0087] To a suspension of lithium aluminium hydride (324 mg, 3.0eq.) and THF (50 ml) at r.t under argon, a solution of (E)-1-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-3-(4-hydroxy-phenyl)-propenone (1.0 g, 2.85 mmol) in THF (10 ml) is slowly added. After stirring for 5 h., a 20% ammonium chloride solution (20 ml) is carefully added, and the aqueous layer is extracted with dichloromethane. The organic layer is dried (Na₂SO₄), filtered and evaporated. The oily residue is purified by chromatography (Silica gel, dichloromethane-methanol-25% aqueous ammonia 140:10:1) to give (E)-1-[3-(4-hydroxy-phenyl)-allyl]-4-(4-methyl-benzyl)-piperidin-4-ol (474 mg, 49%) as a white foam. MS: $m/e = 338$ (M+H)⁺.

Synthesis of Intermediates:

Example 39

4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-carboxylic acid ethylester

[0088] A solution of 1-ethoxycarbonyl-4-piperidone (39 ml, 0.26 mol) in diethylether (150 ml) was added dropwise at room temperature to a solution prepared from 4-methyl-benzylbromide (237 g, 1.28 mol) and Mg (31.2 g, 1.28 mol) in diethylether (300 ml). Room temperature was maintained for 45 min with stirring and the mixture was then refluxed for 5 h. It was cooled to 0°C, diluted with diethylether (700 ml) and hydrolyzed with saturated ammoniumhydrochloride solution (200 ml) and water (350 ml). Insoluble material was removed by filtration over Celite, the residue washed

twice with diethylether (2x500 ml) and the organic phase was separated. The water layer was extracted with diethyl-ether, the organic phases were pooled and dried with MgSO_4 and the solvent evaporated. The residue was chromatographed over silica gel (hexane-ethyl acetate, 2:1) to give 4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-carboxylic acid ethylester (70.5 g, 99%) as a yellowish oil, MS: $m/e = 278$ ($\text{M}+\text{H}^+$).

[0089] Following the general method of Example 39 the compound of Example 40 was prepared.

Example 40

4-(4-Fluoro-benzyl)-4-hydroxy-piperidin-1-carboxylic acid ethylester

[0090] The title compound was prepared from 1-ethoxycarbonyl-4-piperidone and 4-fluoro-benzylbromide.

Example 41

4-(4-Methyl-benzyl)-piperidin-4-ol

[0091] A mixture of 4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-carboxylic acid ethylester (70.5 g, 0.25 mol) and sodium hydroxide (26 g, 0.65 mol) in ethanol (350 ml) and water (50 ml) was refluxed for 2 days. Sodium hydroxide (20 g, 0.50 mol) was added and refluxing commenced for another day before cooling to room temperature and evaporating the solvent. The residue was taken up with CH_2Cl_2 (700 ml) and water (1 l), the organic phase was separated and the water phase extracted with CH_2Cl_2 . The organic phases were pooled, dried with MgSO_4 and the solvent was evaporated. The residue was crystallized from n-hexane to give 4-(4-methyl-benzyl)-piperidin-4-ol (34 g, 66%) as an off-white solid, m.p. 118-121°C and MS: $m/e = 206$ (M^+).

[0092] Following the general method of Example 41 the compounds of Example 42 to Example 43 were prepared.

Example 42

4-(4-Fluoro-benzyl)-piperidin-4-ol

[0093] The title compound was prepared from 4-(4-fluoro-benzyl)-4-hydroxy-piperidin-1-carboxylic acid ethylester.

Example 43

4-(4-Methoxy-benzyl)-piperidin-4-ol

[0094] The title compound was prepared from 4-(4-methoxy-benzyl)-4-hydroxy-piperidin-1-carboxylic acid ethylester.

Example 44

(R)-[4-(4-(Phenylmethoxy)phenoxy)methyl]-oxirane

[0095] A mixture of hydroquinone monobenzylether (1.7 g, 8.5 mmol) and tetramethylammoniumchloride (0.19 g, 1.7 mmol) in (S)-epichlorohydrine (2.0 ml, 25.5 mmol) was stirred at room temperature for 4 days. H_2O (30 ml) and CH_2Cl_2 (50 ml) were added and the organic phase was separated. The water phase was extracted two times with CH_2Cl_2 . The organic phases were then pooled, dried with Na_2SO_4 and the solvent evaporated. The residue was chromatographed over silica gel (hexane- Et_2O , 3:1) to give (R)-[4-(4-(Phenylmethoxy)phenoxy)methyl]-oxirane (1.1 g, 50%) as a colourless solid, m.p. 70-73°C, $[\alpha]_D^{20} = -8.1^\circ$ ($c = 1.0$, methanol) and MS: $m/e = 256$ (M^+).

Example 45

(RS)-1-[3-(4-Benzyloxy-phenoxy)-2-hydroxy-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol

[0096] A mixture of (RS)-1-chloro-3-[4-(benzyloxy)phenoxy]-2-propanol (1.0 g, 3.4 mmol), 4-(4-methyl-benzyl)-piperidin-4-ol (0.70 g, 3.4 mmol) and potassium carbonate (0.50 g, 3.6 mmol) in 2-butanone was refluxed for 2 days. It was cooled to room temperature, 50 ml of H_2O were added and the organic phase was separated. The water phase was extracted two times with ethyl acetate. The organic phases were then pooled, dried with Na_2SO_4 and the solvent evaporated. The residue was chromatographed over silica gel (CH_2Cl_2 -MeOH, 98:2) to give (RS)-1-[3-(4-benzyloxy-

phenoxy)-2-hydroxy-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol as a colourless solid (0.75 g, 48%). MS: m/e = 462.5 (M+H⁺)

[0097] Following the general method in Example 45 the intermediates of Example 46 to Example 47 were prepared.

5 Example 46

(RS)-4-Benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-piperidin-4-ol

10 [0098] The title compound was prepared from (RS)-1-chloro-3-[4-(benzyloxy)phenoxy]-2-propanol and 4-benzyl-4-hydroxy-piperidine.

Example 47

(RS)-1-[3-(4-Benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-4-(4-fluoro-benzyl)-piperidin-4-ol

15 [0099] The title compound, MS: m/e = 466.5 (M+H⁺), was prepared from (RS)-1-chloro-3-[4-(benzyloxy)phenoxy]-2-propanol and 4-(4-Fluoro-benzyl)-piperidin-4-ol (Example 34).

Example 48

20 (R)-4-Benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-piperidin-4-ol

[0100] (R)-{[4-(Phenylmethoxy)phenoxy]methyl}-oxirane (0.55 g, 2.2 mmol) and 4-benzyl-4-hydroxy-piperidine (0.49 g, 2.4 mmol) were dissolved in ethanol (10 ml) and refluxed for 2h. After evaporation of the solvent the residue was chromatographed over silica gel (ethyl acetate-MeOH, 9:1) to give (R)-4-benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-piperidin-4-ol (0.85 g, 88%) as colourless oil. MS: m/e = 448.5 (M+H⁺).

Example 49

30 (S)-4-Benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-piperidin-4-ol

[0101] (S)-{[4-(Phenylmethoxy)phenoxy]methyl}-oxirane (0.55 g, 2.2 mmol) and 4-benzyl-4-hydroxy-piperidine (0.49 g, 2.4 mmol) were dissolved in ethanol (10 ml) and refluxed for 2h. After evaporation of the solvent the residue was chromatographed over silica gel (ethyl acetate-MeOH, 9:1) to give (S)-4-benzyl-1-[3-(4-benzyloxy-phenoxy)-2-hydroxy-propyl]-piperidin-4-ol (0.89 g, 92%) as colourless oil. MS: m/e = 448.5 (M+H⁺).

Example 50

40 (RS)-1-[3-(4-Amino-phenoxy)-2-hydroxy-propyl]-4-benzyl-piperidin-4-ol hydrochloride

[0102] (RS)-4-Benzyl-1-[2-hydroxy-3-(4-nitro-phenoxy)-propyl]-piperidin-4-ol hydrochloride (3.0 g, 7.1 mmol) was dissolved in a mixture of ethanol (250 ml) and MeOH (80 ml) and hydrogenated in the presence of Pd on C at room temperature and atmospheric pressure. After filtration and evaporation of the solvent the residue was dissolved in ethanol (20 ml) and ethyl acetate (40 ml) to give (RS)-1-[3-(4-amino-phenoxy)-2-hydroxy-propyl]-4-benzyl-piperidin-4-ol hydrochloride (2.5 g, 90%) as beige solid mixture of the E/Z isomers, m.p. 93-95°C and MS: m/e = 357.4 (M+H⁺).

Example 51

50 4-Benzyl-1-(3-chloro-2-hydroxy-propyl)-piperidin-4-ol

[0103] (rac)-Epichlorohydrin (2.5 ml, 31 mmol) dissolved in diethylether (10 ml) was added at room temperature to a suspension of 4-benzyl-4-hydroxy-piperidine (6.0 g, 31 mmol) in diethylether (40 ml) and CH₂Cl₂ (40 ml). The mixture was stirred overnight at room temperature, water (50 ml) and CH₂Cl₂ (50 ml) were added and the organic phase was separated. The water phase was extracted with CH₂Cl₂, the organic phases were pooled, dried with Na₂SO₄ and the solvents evaporated. The residue was chromatographed over silica gel (ethyl acetate-MeOH, 9:1) to give 4-benzyl-1-(3-chloro-2-hydroxy-propyl)-piperidin-4-ol (1.0 g, 13%) as a colourless solid, m.p. 194-195°C and MS: m/e = (M+H⁺).

Exempl 524-Benzyl-1-[2-(4-benzyloxy-phenoxy)-ethyl]-piperidin-4-ol

[0104] A mixture of 4-benzyl-4-hydroxy-piperidine (0.62 g, 3.3 mmol), 1-(2-bromoethoxy)-4-(phenylmethoxy)-benzene (1.0 g, 3.3 mmol) and potassium carbonate (0.9 g, 6.5 mmol) in 2-butanone (15 ml) was refluxed overnight. It was cooled to room temperature, 30 ml of H₂O were added and the organic phase was separated. The water phase was extracted two times with ethyl acetate. The organic phases were then pooled, dried with Na₂SO₄ and the solvent evaporated to give 4-benzyl-1-[2-(4-benzyloxy-phenoxy)-ethyl]-piperidin-4-ol as a yellowish solid (1.35 g, 99%). MS: m/e 418.4 (M+H⁺).

[0105] Following the general method of Example 52 the compounds of Example 53 to Example 60 were prepared.

Example 531-[2-(4-Benzylloxy-phenoxy)-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol

[0106] The title compound, MS: m/e = 432.6 (M+H⁺), was prepared from 1-(2-bromoethoxy)-4-(benzyloxy)-benzene and 4-(4-methyl-benzyl)-piperidin-4-ol.

Example 541-[2-(4-Benzylloxy-phenoxy)-ethyl]-4-(4-fluor-benzyl)-piperidin-4-ol

[0107] The title compound, MS: m/e = 436.5 (M+H⁺), was prepared from 1-(2-bromoethoxy)-4-(benzyloxy)-benzene and 4-(4-fluoro-benzyl)-piperidin-4-ol.

Example 554-Benzyl-1-[3-(4-benzyloxy-phenoxy)-propyl]-piperidin-4-ol

[0108] The title compound, MS: m/e = 432.6 (M+H⁺), was prepared from 1-(2-bromopropoxy)-4-(benzyloxy)-benzene and 4-benzyl-piperidin-4-ol.

Example 561-[3-(4-benzyloxy-phenoxy)-propyl]-4-(4-fluoro-benzyl)-piperidin-4-ol.

[0109] The title compound, MS: m/e = 450.5 (M+H⁺), was prepared from 1-(3-bromopropoxy)-4-(benzyloxy)-benzene and 4-(4-fluor-benzyl)-piperidin-4-ol.

Example 571-[3-(3-benzyloxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol.

[0110] The title compound, MS: m/e = 446.5 (M+H⁺), was prepared from 1-(3-bromopropoxy)-3-(phenylmethoxy)-benzene and 4-(4-methyl-benzyl)-piperidin-4-ol.

Example 581-[3-(2-benzyloxy-phenoxy)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol.

[0111] The title compound, MS: m/e = 446.5 (M+H⁺), was prepared from 1-(3-bromopropoxy)-2-(benzyloxy)-benzene and 4-(4-methyl-benzyl)-piperidin-4-ol.

Example 59

1-[2-(4-benzyloxy-phenoxy)-ethyl]-4-(4-methoxy-benzyl)-piperidin-4-ol

- 5 [0112] The title compound, MS: $m/e = 448.5$ ($M+H^+$), was prepared from 1-(2-bromoethoxy)-4-(benzyloxy)-benzene and 4-(4-methoxy-benzyl)-piperidin-4-ol.

Example 60

10 1-[2-(4-benzyloxy-phenoxy)-ethyl]-4-(4-methoxy-benzyl)-piperidin-4-ol

- [0113] The title compound, MS: $m/e = 446.4$ ($M+H^+$), was prepared from methanesulfonic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-1-methyl ethyl ester and 4-benzyloxy-phenol.

Example 61

2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-acetamide

- 20 [0114] N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-acetamide (1.14 g, 3.8 mmol) was dissolved in DMF (12 ml) and stirred for 19 hours at room temperature in the presence of triethylamine (0.79 ml, 5.7 mmol) and 4-benzyl-4-hydroxypiperidin (0.87g, 4.56 mmol). The reaction mixture was concentrated, dissolved in CH_2Cl_2 and washed with H_2O (2x30ml). The organic phase was dried over Na_2SO_4 and concentrated. The residue was chromatographed over silica gel (hexane-ethyl acetate 1:1 then ethyl acetate) to provide 2-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-acetamide (1.32 g, 78%) as a yellow solid, m.p. 105-108°C and MS: $m/e = 455.5$ ($M+H^+$).
- 25 [0115] Following the general method of Example 61 the compounds of Example 62 to Example 65 were prepared.

Example 62

N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-acetamide

- 30 [0116] The title compound, m.p. 136-138°C and MS: $m/e = 468$ (M^+), was prepared from N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-acetamide and 4-(4-Methyl-benzyl)-piperidin-4-ol.

Example 63

35 N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-[4-(4-chloro-benzyl)-4-hydroxy-piperidin-1-yl]-acetamide

- [0117] The title compound, m.p. 135-136°C and MS: $m/e = 489.4$ (M^+), was prepared from N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-acetamide and 4-(4-Chloro-benzyl)-piperidin-4-ol.
- 40

Example 64

(RS)-N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propionamide

- 45 [0118] The title compound, m.p. 134-138°C and MS: $m/e = 483.3$ ($M+H^+$), was prepared from (RS)-N-[4-tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-propionamide and 4-(4-Methyl-benzyl)-piperidin-4-ol.

Example 65

50 3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-N-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-propionamide

- [0119] The title compound, MS: $m/e = 468$ (M^+), was prepared from N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-3-chloro-propionamide and 4-benzyl-4-hydroxypiperidin.
- 55

Exempl 66N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-acetamide

5 **[0120]** 4-(tert-Butyl-dimethyl-silanyloxy)-phenylamine (2.23 g, 10 mmol) was dissolved in acetone (25 ml). After addition of Na₂CO₃ (3.2 g, 30 mmol), chloroacetylchloride (0.96 ml, 12 mmol) was added dropwise. After 1 hour at room temperature the reaction mixture was quenched with H₂O (100 ml) and the aqueous phase was extracted with CH₂Cl₂ (3x10ml). Combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexane-ethyl acetate 9:1 then hexane-ethyl acetate 4:1) to provide N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-acetamide (2.55 g, 71%) as a colorless solid, m.p. 107-108°C and MS: m/e = 299 (M⁺).

10 **[0121]** Following the general method of Example 66 the compounds of Example 67 to Example 68 were prepared.

Example 6715 (RS)-N-[4-tert-Butyl-dimethyl-silanyloxy)-phenyl]-2-chloro-propionamide

[0122] The title compound, m.p. 74-75°C and MS: m/e = 313 (M⁺), was prepared from 4-(tert-Butyl-dimethyl-silanyloxy)-phenylamine and (RS)-2-chloropropionyl chloride.

20 **Example 68**N-[4-(tert-Butyl-dimethyl-silanyloxy)-phenyl]-3-chloro-propionamide

[0123] The title compound, m.p. 126°C and MS: m/e = 313 (M⁺), was prepared from 4-(tert-Butyl-dimethyl-silanyloxy)-phenylamine and 3-chloropropionyl chloride.

Example 694-(tert-Butyl-dimethyl-silanyloxy)-phenylamine

30 **[0124]** tert-Butyl-dimethyl-(4-nitro-phenoxy)-silane (7.3 g, 2.9 mmol) was dissolved in MeOH (75 ml) and hydrogenated in the presence of Pd on C (10%, E 101 N/D) at room temperature and atmospheric pressure for 1 hour. The catalyst was filtered and the solvent was evaporated to provide 4-(tert-Butyl-dimethyl-silanyloxy)-phenylamine (6.4 g, 99%) as light yellow oil, MS: m/e = 223 (M⁺).

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Example 70tert-Butyl-dimethyl-(4-nitro-phenoxy)-silane

40 **[0125]** 4-Nitrophenol (5.6 g, 40 mmol) was dissolved in CH₂Cl₂ (200 ml) and stirred at room temperature in the presence of tertbutyldimethyl-silyl chloride (7.8 g, 52 mmol), 4-dimethylaminopyridine (0.1 g, 0.8 mmol) and triethylamine (7.2 ml, 52 mmol). After 30 minutes at room temperature the reaction mixture was washed with H₂O (2x200 ml) and the resulting aqueous phases were extracted with CH₂Cl₂ (100 ml). The combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexane-ether 9:1) to provide tert-Butyl-dimethyl-(4-nitro-phenoxy)-silane (10 g, 100%) as a yellow solid, m.p. 36-38°C and MS: m/e = 253 (M⁺).

45

Example 711-(4-Benzyl-4-hydroxy-piperidin-1-yl)-3-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-propan-2-one

50

[0126] To a solution of oxalylchloride (0.28 ml, 3.3 mmol) in CH₂Cl₂ (4 ml) at -78°C was added dropwise DMSO (0.47 ml, 6.6 mmol). After 30 min. a solution of (RS)-4-Benzyl-1-[3-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-2-hydroxy-propyl]-piperidin-4-ol (0.75 g, 1.65 mmol) in CH₂Cl₂ (4 ml) was added. After another hour at -78°C, triethylamine (1.8 ml, 13.2 mmol) was added and reaction mixture was allowed to warm up slowly to room temperature. After 1 hour, 20% NH₄Cl (15 ml) was added, the resulting aqueous phase was extracted with CH₂Cl₂ (3x30 ml). Combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexane-ethylacetate 1:1 then ethyl acetate) to provide 1-(4-Benzyl-4-hydroxy-piperidin-1-yl)-3-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-propan-2-one (0.4 g, 54%) as a yellow oil, and MS: m/e = 454.5 (M+H⁺).

55

Example 72(RS)-4-Benzyl-1-{3-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-2-hydroxy-propyl}-piperidin-4-ol

- 5 **[0127]** (RS)-tert-Butyl-dimethyl-(4-oxiranylmethyl-phenoxy)-silane (0.62 g, 2.34 mmol) was dissolved in MeOH (8 ml) and stirred overnight at room temperature in the presence of 4-benzyl-4-hydroxy-piperidine (0.9 g, 4.68 mmol). The reaction mixture was concentrated and the residue was chromatographed over silica gel (hexane-ethylacetate 1:1, then CH₂Cl₂-MeOH 19:1) to provide (RS)-4-Benzyl-1-{3-[4-(tert-butyl-dimethyl-silanyloxy)-phenyl]-2-hydroxy-propyl}-piperidin-4-ol (0.95 g, 90%) as a yellow oil, MS: m/e = 456.5 (M+ H⁺).

Example 73(RS)-tert-Butyl-dimethyl-(4-oxiranylmethyl-phenoxy)-silane

- 15 **[0128]** (RS)-4-Oxiranylmethyl-phenol (1 g, 6.66 mmol) was dissolved in CH₂Cl₂ (50 ml) and stirred at room temperature in the presence of tert-butyldimethylsilyl chloride (1.3 g, 8.66 mmol), 4-dimethyl-aminopyridine (0.018 g, 0.15 mmol) and triethylamine (1.2 ml, 8.66 mmol). After 22 hours at room temperature the reaction mixture was washed with H₂O (2x100 ml) and the resulting aqueous phases were extracted with CH₂Cl₂ (100 ml). The combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexane-ethylacetate 9:1) to provide (RS)-tert-Butyl-dimethyl-(4-oxiranylmethyl-phenoxy)-silane (1.44 g, 82%) as yellow oil, MS: m/e = 264 (M⁺).

Example 74(RS)-4-Oxiranylmethyl-phenol

- 25 **[0129]** 4-allylphenol (8.9 g, 66.3 mmol) was dissolved in CH₂Cl₂ (180 ml). After addition of NaHCO₃ (8.4 g, 99.5 mmol), m-chloroperbenzoic acid 70% (18 g, 73 mmol) was added portionwise. After 6 hours at room temperature, additional NaHCO₃ (8.4 g, 99.5 mmol) and m-chloroperbenzoic acid 70% (18 g, 73 mmol) were added. After 17 hours, the reaction mixture was washed with sat. NaHCO₃ (200 ml) and the resulting aqueous phases were extracted with CH₂Cl₂ (3x100ml). The combined organic phases were washed with sat. Na₂S₂O₃ (2x100ml), dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexane-ethyl acetate 9:1 then 1:1) to provide (RS)-4-oxiranylmethyl-phenol (3.77 g, 38%) as yellow solid, m.p. 54-57°C and MS: m/e = 150 (M⁺).

Example 754-allylphenol

- 30 **[0130]** To a -78°C cold solution of 4-allylanisole (14.6 ml, 95 mmol) in CH₂Cl₂ (300 ml) BBr₃ (100 ml, 0.1 mol, 1mol/l in CH₂Cl₂) was added dropwise. The reaction mixture was then allowed to warm up to room temperature. After 1 hour, the reaction mixture was cooled to 0°C and quenched slowly with H₂O (90 ml). The resulting aqueous phase was extracted with CH₂Cl₂ (2x100ml). The combined organic phases were dried over Na₂SO₄ and concentrated. The residue was chromatographed over silica gel (hexane-ethyl acetate 9:1) to provide 4-allylphenol (11.3 g, 89%) as a purple oil, MS: m/e = 134 (M⁺).

Example 764-Benzoyloxy-benzoic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl ester

- 50 **[0131]** 4-Benzoyloxybenzoic acid (0.685 g, 3 mmol) was dissolved in DMF (6 ml), and 1,1'-carbonyldiimidazole (0.58 g, 3.6 mmol) was added portionwise. The reaction mixture was heated to 55-60°C for 20 min. and then cooled to room temperature. A solution of 1-(2-hydroxy-ethyl)-4-(4-methyl-benzyl)-piperidin-4-ol (0.78 g, 3.3 mmol) in DMF (2 ml) was added. The reaction mixture was stirred 23 hours at room temperature and 4 hours at 60°C. H₂O (50 ml) was added followed by CH₂Cl₂. Organic phase was washed with sat. NaHCO₃, dried over Na₂SO₄, and concentrated. The residue was chromatographed over silica gel (CH₂Cl₂-MeOH, 19:1) to provide 4-benzoyloxy-benzoic acid 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl ester (0.65 g, 47%) as a colorless solid, m.p. 102°C and MS: m/e=460.3 (M+H⁺).
- 55 **[0132]** Following the general method of Example 71+aaa the compound of Example 72+aaa was prepared.

Exempl 774-Benzyloxy-benzoic acid 3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl ester

- 5 **[0133]** The title compound, MS: $m/e=474.4$ ($M+H^+$) was prepared from 1-(3-hydroxy-propyl)-4-(4-methyl-benzyl)-piperidin-4-ol.

Example 7810 1-(2-Hydroxy-ethyl)-4-(4-methyl-benzyl)-piperidin-4-ol

- [0134]** A mixture containing 4-(4-methyl-benzyl)-piperidin-4-ol (5.1 g, 25 mmol), 2-bromoethanol (1.8 ml, 25 mmol) and K_2CO_3 (5.2 g, 37.5 mmol) in 2-butanone (120 ml) was refluxed for 22 hours. H_2O (30 ml) was added and the aqueous phase was extracted with ethylacetate. Combined organic phases were dried over Na_2SO_4 , and concentrated.
- 15 The residue was chromatographed over silica gel (CH_2Cl_2 -MeOH, 9:1 + NH_4OH (1%)) to provide 1-(2-hydroxy-ethyl)-4-(4-methyl-benzyl)-piperidin-4-ol (4.3 g, 73%) as a yellow oil, MS: $m/e=235.3$ (M^+).
- [0135]** Following the general method of Example 78 the compound of Example 79 was prepared.

Example 7920 1-(3-Hydroxy-propyl)-4-(4-methyl-benzyl)-piperidin-4-ol

- [0136]** The title compound, MS: $m/e=263.3$ (M^+) was prepared from 4-(4-methyl-benzyl)-piperidin-4-ol and 3-bromo-1-propanol.

25

Example 804-Benzyloxy-N-(2-hydroxy-ethyl)-benzamide

- 30 **[0137]** A solution of 4-benzyloxy benzoic acid (20 g, 87.6 mmol), 1,1'-carbonyl-diimidazole (14.9 g, 91.8 mmol) and DMF (80 ml) was stirred at 50 °C for 1 h. The solution is cooled to 0°C, and ethanolamine (25% in water, 81.2 g) is added. After 45 min. the precipitate was filtered to give 4-benzyloxy-N-(2-hydroxy-ethyl)-benzamide (22.49 g, 94.5%) as a white solid. MS: $m/e = 271$ (M^+).

35 **Example 81**4-Benzyloxy-N-(2-chloro-ethyl)-benzamide

- 40 **[0138]** Phosgene was bubbled through a suspension of 4-benzyloxy-N-(2-hydroxy-ethyl)-benzamide (22.49 g, 82.8 mmol) in dioxane (130 ml) until all the insoluble material had dissolved. Excess phosgene was removed by a stream of carbon dioxide. The solvent was removed at reduced pressure, and the residue was dried for 1 h. at 100°C. The crude product was recrystallized from ethyl acetate to yield 4-benzyloxy-N-(2-chloro-ethyl)-benzamide (16.3 g, 68%).

Example 8245 4-Benzyloxy-N-[2-(4-hydroxy-4-phenyl-piperidin-1-yl)-ethyl]-benzamide

- [0139]** A mixture of 4-benzyloxy-N-(2-chloro-ethyl)-benzamide (2.1 g, 7.25 mmol), 4-benzyl-4-hydroxy-piperidine (1.386 g, 7.25 mmol), potassium carbonate (2.0 g, 14.5 mmol) and 2-butanone (40 ml) was stirred for 15 h at 60°C.
- 50 After the addition of water, the mixture was extracted with ethyl acetate. The organic layer was dried (Na_2SO_4), filtered and evaporated. The residue was purified by chromatography (silica gel, methylene chloride methanol from 95:5 to 9:1) to give 4-benzyloxy-N-[2-(4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl)-ethyl]-benzamide (680 mg, 21%) as a light yellow solid. MS: $m/e = 445$ ($M+H^+$).

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Example 834-Benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-benzamide

5 [0140] A mixture of 4-benzyloxy-N-(2-chloro-ethyl)-benzamide (2.0 g, 6.9 mmol), 4-hydroxy-4-(4-methyl-benzyl)-piperidine (1.06 g, 5.18 mmol), potassium carbonate (1.43 g, 10.35 mmol) and 2-butanone (40 ml) was stirred for 15 h at 60°C. After the addition of water, the mixture was extracted with ethyl acetate. The organic layer was dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica gel, methylene chloride:methanol from 95:5 to 9:1) to give 4-benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-benzamide (445 mg, 19%) as a light yellow solid. MS: m/e = 459 (M+H)⁺.

Example 844-Benzyloxy-N-(3-chloro-propyl)-benzamide

15 [0141] A mixture of 4-benzyloxy benzoic acid (5.0 g, 21.9 mmol), 1,1'-carbonyl-diimidazole (3.6 g, 1.05 eq.) and DMF (50 ml) was stirred at 50°C for 1 h. After cooling to r.t., 3-chloropropylamine hydrochloride (3.4 g, 26.1 mmol) and sodium carbonate (3.5 g, 32.0 mmol) were added and stirring continued for 45 min. After the addition of water, the mixture was extracted with ether. The organic layer was dried (Na₂SO₄), filtered and evaporated to give 4-benzyloxy-N-(3-chloro-propyl)-benzamide (5.44 g, 85 %) as a white solid. MS: m/e = 304 (M+H)⁺.

Example 85N-[3-(4-Benzyl-4-hydroxy-piperidin-1-yl)-propyl]-4-benzyloxy-benzamide

25 [0142] A mixture of 4-benzyloxy-N-(3-chloro-propyl)-benzamide (0.5 g, 1.64 mmol), 4-benzyl-4-hydroxy-piperidine (0.315 g, 1.65 mmol), potassium carbonate (0.45 g, 3.29 mmol) and 2-butanone (10 ml) was stirred at 60°C for 48 h. After the addition of water, the mixture was extracted with ethyl acetate. The organic layer was dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica gel, methylene chloride:methanol from 95:5 to 9:1) to give N-[3-(4-benzyl-4-hydroxy-piperidin-1-yl)-propyl]-4-benzyloxy-benzamide (185 mg, 25%) as a light yellow solid. MS: m/e = 459 (M+H)⁺.

Example 864-Benzyloxy-N-[3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl]-benzamide

35 [0143] A mixture of 4-benzyloxy-N-(3-chloro-propyl)-benzamide (0.5 g, 1.64 mmol), 4-hydroxy-4-(4-methyl-benzyl)-piperidine (0.34 g, 1.65 mmol), potassium carbonate (0.45 g, 3.29 mmol) and 2-butanone (10 ml) was stirred at 60°C for 48 h. After the addition of water, the mixture was extracted with ethyl acetate. The organic layer was dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica gel, methylene chloride:methanol from 95:5 to 9:1) to give 4-benzyloxy-N-[3-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-propyl]-benzamide (220 mg, 28%) as light yellow solid. MS: m/e = 473 (M+H)⁺.

Example 871-(2-methylamino-ethyl)-4-(4-methyl-benzyl)-piperidin-4-ol

45 [0144] A mixture of 4-hydroxy-4-(4-methyl-benzyl)-piperidine (1.56 g, 7.6 mmol), sodium carbonate (0.89 g, 8.4 mmol), N-methyl-chloro-acetamide and acetone (14 ml) was stirred at r.t. for 48 h. After evaporation of the solvent, water was added to the slurry. The aqueous layer was extracted with ether, and the organic layer was dried (Na₂SO₄), filtered and evaporated to give a residue which upon trituration with ether gave 1.3 g of white crystalline material. This was then added portionwise to a stirred suspension of lithium aluminium hydride (350 mg, 9.2 mmol) in THF (30 ml) at 0°C. After stirring overnight at r.t., and heating at reflux temperature for 1 h, the reaction was cooled to 0°C and water, 15% sodium hydroxide and again water (each time 1 ml) were carefully added. Filtration, evaporation of the solvent from the filtrate, addition of water and extraction with methylene chloride gave after drying (Na₂SO₄), filtration and evaporation 1-(2-methylamino-ethyl)-4-(4-methyl-benzyl)-piperidin-4-ol (480 mg). MS: m/e = 263 (M+H)⁺.

Example 884-Benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-N-methyl-benzamide

[0145] A mixture of 4-benzyloxy benzoic acid (265 mg, 1.16 mmol), 1,1'-carbonyl-diimidazole (197 mg, 1.21 mmol) and DMF (7 ml) was stirred at 50°C for 1 h. After cooling to r.t., 1-(2-methylamino-ethyl)-4-(4-methyl-benzyl)-piperidin-4-ol (335 mg, 1.27 mmol) was added and stirring was continued for 1h. After the addition of water, the mixture was extracted with ether. The organic layer was dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica gel, dichloromethane-methanol 95:5) to give 4-benzyloxy-N-[2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethyl]-N-methyl-benzamide (226 mg) as a pale yellow oil. MS: m/e = 473 (M+H)⁺.

Example 89(E)-1-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-3-(4-methoxy-phenyl)-propenone

[0146] A mixture of 4-methoxy cinnamic acid (3.0 g, 16.8 mmol), 1,1'-carbonyl-diimidazole (2.78 g, 1.05 eq.) and DMF (50 ml) is stirred at 50°C for 1 h. After cooling to r.t., 4-(4-methyl-benzyl)-4-hydroxy-piperidine (3.63 g, 1.05 eq.) is added and stirring is continued for 1 h. Water is then added, and the mixture is extracted with ether. Drying (Na₂SO₄), filtering, and evaporation of the organic layer afforded (E)-1-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-3-(4-methoxy-phenyl)-propenone (5.87 g, 95%) as a white foam. MS: m/e = 365 (M)⁺.

Example 90(E)-1-[4-Hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-3-(4-hydroxy-phenyl)-propenone

[0147] To a solution of (E)-1-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-3-(4-methoxy-phenyl)-propenone (1.68 g, 4.6 mmol) in dichloromethane (50 ml) at 0°C, a 1M boron tribromide in dichloromethane solution (9.2 ml, 2.0 eq.) is added. After stirring at r.t. for 4 h, water (50 ml) and an aqueous sodium bicarbonate solution (20 ml) is added and the aqueous layer is extracted with dichloromethane. The organic layer is dried (Na₂SO₄), filtered and evaporated to give (E)-1-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-3-(4-hydroxy-phenyl)-propenone (1.423 g, 88%) as a white foam. MS: m/e = 351 (M)⁺.

Example 91

[0148]

Tablet

Formulation (Wet Granulation)					
Item	Ingredients	mg/tablet			
		5 mg	25 mg	100mg	500mg
1.	Compound of formula 1	5	25	100	500
2.	Lactose Anhydrous DTG	125	105	30	150
3.	Sta-Rx 1500	6	6	6	30
4.	Microcrystalline Cellulose	30	30	30	150
5.	Magnesium Stearate	1	1	1	1
	Total	167	167	167	835

Manufacturing Procedure

[0149]

1. Mix items 1, 2, 3 and 4 and granulate with purified water.
2. Dry the granulation at 50°C.
3. Pass the granulation through suitable milling equipment.
4. Add item 5 and mix for three minutes; compress on a suitable press.

Exempl 92

[0150]

Capsule Formulation					
Item Ingredients		mg/tablet			
		5 mg	25 mg	100mg	500mg
1.	Compound of formula 1	5	25	100	500
2.	Hydrous Lactose	159	123	148	---
3.	Corn Starch	25	35	40	70
4.	Talc	10	15	10	25
5.	Magnesium Stearate	1	2	2	5
Total		200	200	300	600

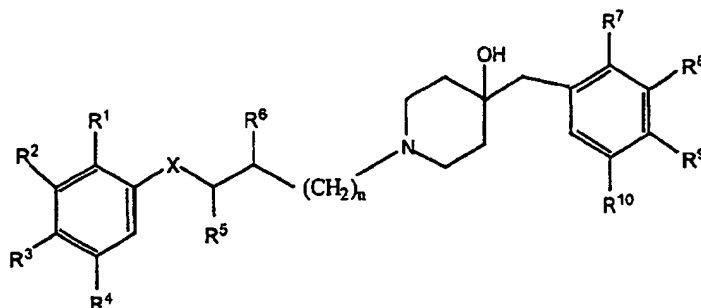
Manufacturing Procedure

[0151]

1. Mix items 1, 2, and 3 in a suitable mixer for 30 minutes.
2. Add items 4 and 5 and mix for 3 minutes.
3. Fill into a suitable capsule.
4. Add item 5 and mix for three minutes; compress on a suitable press.

Claims

1. A compound of the formula



I

wherein

- X is -O-, -NH-, -CH₂-, -CH=, -CO₂-, -CONH-, -CON(C₁₋₄-alkyl)- -S- and -SO₂-;
 R¹-R⁴ are, independently from each other hydrogen, halogen, hydroxy, C₁₋₄ -alkyl-sulfonylamido,
 R⁵, R⁶ are, independently from each other hydrogen, C₁₋₄ -alkyl, hydroxy, C₁₋₄ -alkoxy or oxo;
 R⁷-R¹⁰ are, independently from each other hydrogen, C₁₋₄ -alkyl, halogen, trifluoromethyl or C₁₋₄-alkoxy;
 n is 0 or 1;

and pharmaceutically acceptable acid addition salts thereof.

2. A compound according to claim 1, wherein X is -O-.
3. A compound according to claim 1 selected from the following group:

1-[2-(4-hydroxy-phenoxy)-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 4-(4-fluoro-benzyl)-1-[2-(4-hydroxy-phenoxy)-ethyl]-piperidin-4-ol;
 N-(4-{2-[4-(4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-ethoxy}-phenyl)-methanesulfonamide;
 N-(4-{2-[4-(4-fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)-methanesulfonamide;
 N-(4-{2-[4-(4-chloro-benzyl)-4-hydroxy-piperidin-1-yl]-ethoxy}-phenyl)-methanesulfonamide;
 N-(4-{3-[4-(4-fluoro-benzyl)-4-hydroxy-piperidin-1-yl]-propoxy}-phenyl)-methanesulfonamide;
 1-[2-(4-hydroxy-phenoxy)-1-methyl-ethyl]-4-(4-methyl-benzyl)-piperidin-4-ol.

4. A compound according to claim 1, wherein X is -NH-.

5. A compound according to claim 4 selected from the group consisting of

2-(4-benzyl-4-hydroxy-piperidin-1-yl)-N-(4-hydroxy-phenyl)-acetamide and
 2-[4-hydroxy-4-(4-methyl-benzyl)-piperidin-1-yl]-N-(4-hydroxy-phenyl)-acetamide.

6. A compound according to claim 1, wherein X is -CH₂-.

7. A compound according to claim 6 selected from the following group:

(RS)-4-benzyl-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol;
 (RS)-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-4-(4-methyl-benzyl)-piperidin-4-ol;
 (RS)-4-(4-chloro-benzyl)-1-[2-hydroxy-3-(4-hydroxy-phenyl)-propyl]-piperidin-4-ol.

8. A compound according to claim 1, wherein X is -S- or -SO₂-.

9. A compound according to claim 1, wherein X is -CH=.

10. A compound according to claim 1, wherein X is -CO₂-.

11. A compound according to claim 1, wherein X is -CONH-.

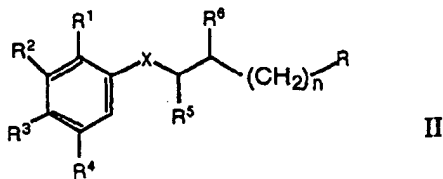
12. A compound according to claim 1, wherein X is -CON(C₁₋₄-alkyl).

13. A medicament containing one or more compounds of any one of claims 1 to 12 or a pharmaceutically acceptable salt thereof and an inert carrier for the treatment of diseases.

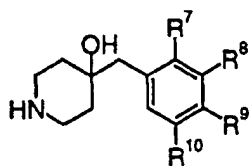
14. A medicament according to claim 13 for the treatment of diseases based on therapeutic indications for NMDA receptor subtype specific blockers, which include acute forms of neurodegeneration caused, e.g., by stroke and brain trauma, and chronic forms of neurodegeneration such as Alzheimer's disease, Parkinson's disease, Huntington's disease, ALS (amyotrophic lateral sclerosis) and neurodegeneration associated with bacterial sclerosis and neurodegeneration associated with bacterial or viral infections.

15. A process for preparing a compound of formula I as defined in claim 1, which process comprises

a) reacting a compound of the formula



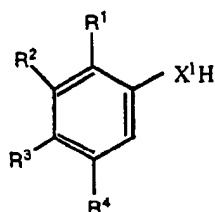
with a compound of the formula



III

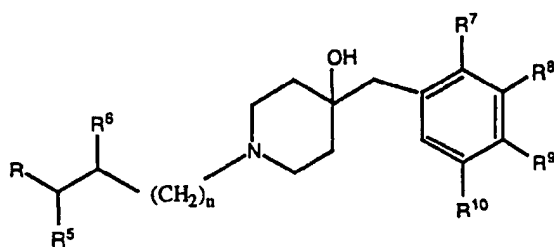
wherein $R^1 - R^{10}$ and X have the significances given in claim 1, n is 1, R is a leaving group and R^6 is an oxo- or hydroxy group, or

b) reacting a compound of the formula



IV

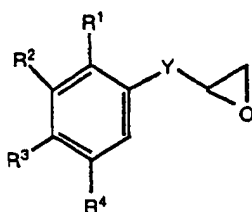
with a compound of the formula



V

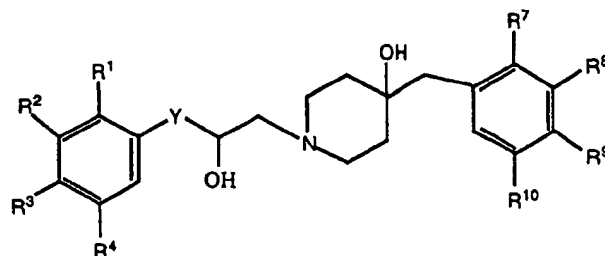
wherein $R^1 - R^{10}$ and n have the significances given in claim 1, R is as described above and X^1 is -O-, -NH-, -N(C₁₋₄-alkyl)- or -S-, or

c) reacting a compound of the formula



VI

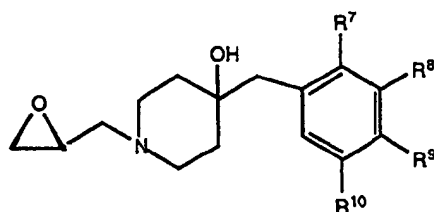
with a compound of the formula III to give a compound of the formula



Ia

wherein $R^1 - R^4$ and $R^7 - R^{10}$ have the significances given in claim 1 and Y denotes $-XCH_2-$ or $-CH_2-$, or

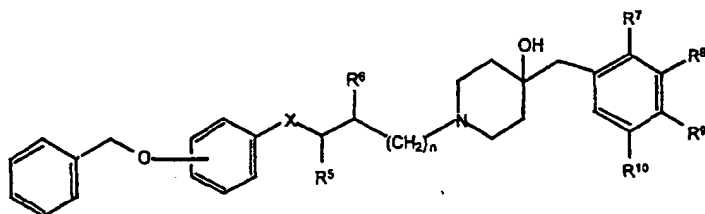
d) reacting a compound of the formula IV with a compound of the formula



VII

to give a compound of the formula Ia, wherein $R^1 - R^4$ and $R^7 - R^{10}$ have the significances given in claim 1, or

e) debenzylating a compound of the formula



VIII

wherein the substituents are as described above, provided that none of $R^7 - R^{10}$ is halogen, or

f) reacting a compound of formula I wherein one of $R^1 - R^4$ is an amino group with a C_{1-4} -alkyl-sulfonyl halogen to give a compound of formula I, wherein one of $R^1 - R^4$ is a C_{1-4} -alkyl-sulfonyl-amino group, or

g) reducing a compound of formula I, wherein R^5 and/or R^6 represents a carbonyl group to yield the corresponding hydroxy compound, or

h) oxidizing a compound of formula I, wherein X represents $-S-$ to yield the corresponding sulfonyl ($-SO_2-$) compound, or

i) cleaving off (a) hydroxy or amino protecting group(s) present as (a) substituent(s) $R^1 - R^4$, and

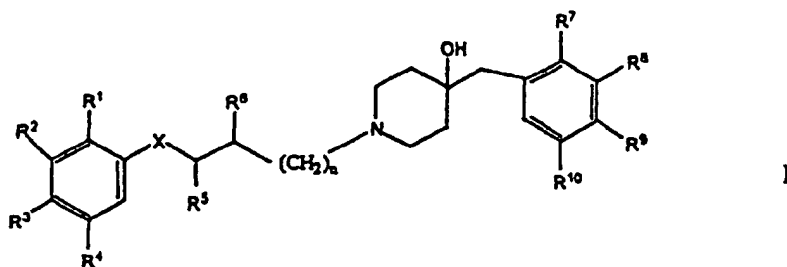
j) if desired, converting the compound of formula I obtained into a pharmaceutically acceptable add addition salt.

16. The use of a compound in accordance with any one of claims 1 - 12 for the treatment of diseases.

17. The use of a compound in accordance with claim 16 for the treatment of diseases based on therapeutic indications for NMDA receptor subtype specific blockers, which include acute forms of neurodegeneration caused e.g. by stroke and brain trauma, and chronic forms of neurodegeneration such as Alzheimer's disease, Parkinson's disease, Huntington's disease, ALS (amyotrophic lateral sclerosis) and neurodegeneration associated with bacterial or viral infections or for the manufacture of a medicament containing such a compound.

Patentansprüche

1. Verbindung der Formel



worin

X	-O-, -NH-, -CH ₂ -, -CH=, -CO ₂ -, -CONH-, -CON(C ₁₋₄ -Alkyl)-, -S- und -SO ₂ - darstellt;
R ¹ - R ⁴	unabhängig voneinander Wasserstoff, Halogen, Hydroxy, C ₁₋₄ -Alkyl-sulfonylamido darstellen;
R ⁵ , R ⁶	unabhängig voneinander Wasserstoff, C ₁₋₄ -Alkyl, Hydroxy, C ₁₋₄ -Alkoxy oder Oxo darstellen;
R ⁷ - R ¹⁰	unabhängig voneinander Wasserstoff, C ₁₋₄ -Alkyl, Halogen, Trifluormethyl oder C ₁₋₄ -Alkoxy darstellen;
n	0 oder 1 ist;

und pharmazeutisch verträgliche Säureadditionssalze davon.

2. Verbindung nach Anspruch 1, worin X -O- darstellt.

3. Verbindung nach Anspruch 1, ausgewählt aus der nachstehenden Gruppe:

1-[2-(4-Hydroxyphenoxy)ethyl]-4-(4-methylbenzyl)piperidin-4-ol;
 4-(4-Fluorbenzyl)-1-[2-(4-hydroxyphenoxy)ethyl]piperidin-4-ol;
 N-(4-{2-[4-Hydroxy-4-(4-methylbenzyl)piperidin-1-yl]-ethoxy}phenyl)methansulfonamid;
 N-(4-{2-[4-(4-Fluorbenzyl)-4-hydroxypiperidin-1-yl]-ethoxy}phenyl)methansulfonamid;
 N-(4-{2-[4-(4-Chlorbenzyl)-4-hydroxypiperidin-1-yl]ethoxy}phenyl)methansulfonamid;
 N-(4-{3-[4-(4-Fluorbenzyl)-4-hydroxypiperidin-1-yl]propoxy}phenyl)methansulfonamid;
 1-[2-(4-Hydroxyphenoxy)-1-methylethyl]-4-(4-methylbenzyl)piperidin-4-ol.

4. Verbindung nach Anspruch 1, worin X -NH- darstellt.

5. Verbindung nach Anspruch 4, ausgewählt aus der Gruppe, bestehend aus

2-(4-Benzyl-4-hydroxypiperidin-1-yl)-N-(4-hydroxyphenyl)acetamid und
 2-[4-Hydroxy-4-(4-methylbenzyl)piperidin-1-yl]-N-(4-hydroxyphenyl)acetamid.

6. Verbindung nach Anspruch 1, worin X -CH₂- darstellt.

7. Verbindung nach Anspruch 6, ausgewählt aus der nachstehenden Gruppe:

(RS)-4-Benzyl-1-[2-hydroxy-3-(4-hydroxyphenyl)propyl]piperidin-4-ol;
 (RS)-1-[2-Hydroxy-3-(4-hydroxyphenyl)propyl]-4-(4-methylbenzyl)piperidin-4-ol;

(RS)-4-(4-Chlorbenzyl)-1-[2-hydroxy-3-(4-hydroxyphenyl)propyl]piperidin-4-ol.

8. Verbindung nach Anspruch 1, worin X -S- oder -SO₂- darstellt.

5 9. Verbindung nach Anspruch 1, worin X -CH= darstellt.

10. Verbindung nach Anspruch 1, worin X -CO₂- darstellt.

11. Verbindung nach Anspruch 1, worin X -CONH- darstellt.

10

12. Verbindung nach Anspruch 1, worin X -CON (C₁₋₄- Alkyl) darstellt.

13. Arzneimittel, enthaltend eine oder mehrere Verbindungen nach einem der Ansprüche 1 bis 12 oder ein pharmazeutisch verträgliches Salz davon und einen inerten Träger zur Behandlung von Krankheiten.

15

14. Arzneimittel nach Anspruch 13 zur Behandlung von Erkrankungen, die auf therapeutischen Indikationen für NMDA-Rezeptor-Subtyp-spezifische Blocker basieren, die akute Formen von Neurodegeneration, verursacht beispielsweise durch Schlaganfall und Hirntrauma, und chronische Formen von Neurodegeneration, wie Alzheimer-Krankheit, Parkinson-Krankheit, Huntington-Krankheit, ALS (amyotrophe laterale Sklerose) und Neurodegeneration, verbunden mit bakterieller Sklerose und Neurodegeneration, verbunden mit bakteriellen oder viralen Infektionen, einschließen.

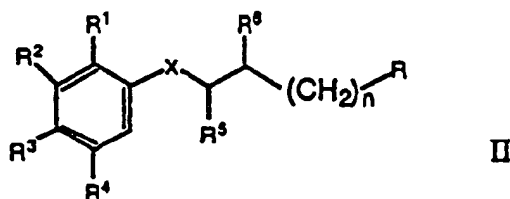
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15. Verfahren zur Herstellung einer Verbindung der Formel I nach Anspruch 1, wobei das Verfahren umfasst

25

a) Umsetzen einer Verbindung der Formel

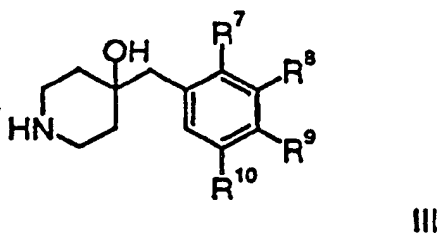
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35

mit einer Verbindung der Formel

40

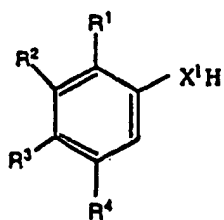


45

worin R¹ - R¹⁰ und X die in Anspruch 1 angegebenen Bedeutungen aufweisen, n 1 ist, R eine Abgangsgruppe darstellt und R⁶ eine Oxo- oder Hydroxygruppe darstellt, oder
b) Umsetzen einer Verbindung der Formel

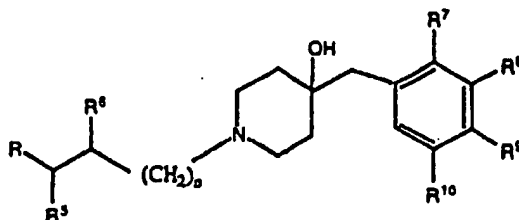
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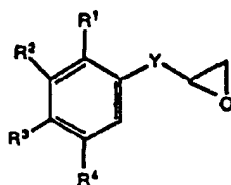
IV

mit einer Verbindung der Formel



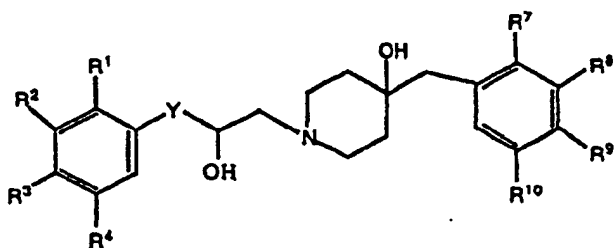
V

worin R¹ - R¹⁰ und n die in Anspruch 1 ausgewiesenen Bedeutungen aufweisen, R wie vorstehend beschrieben ist und X¹ -O-, -NH-, -N(C₁₋₄-Alkyl) - oder -S- darstellt, oder
c) Umsetzen einer Verbindung der Formel



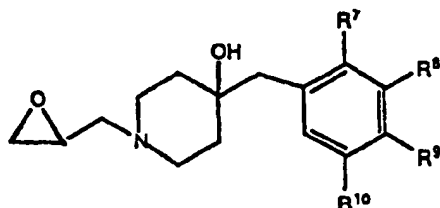
VI

mit einer Verbindung der Formel III, unter Gewinnung einer Verbindung der Formel



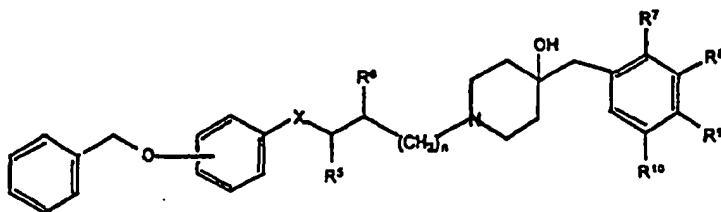
Ia

worin R¹ - R⁴ und R⁷ - R¹⁰ die in Anspruch 1 angegebenen Bedeutungen aufweisen und Y -XCH₂- oder -CH₂- bedeutet, oder
d) Umsetzen einer Verbindung der Formel IV mit einer Verbindung der Formel



VII

unter Gewinnung einer Verbindung der Formel Ia, worin $R^1 - R^4$ und $R^7 - R^{10}$ die in Anspruch 1 angegebenen Bedeutungen aufweisen, oder
e) Debenzylierung einer Verbindung der Formel



VIII

worin die Substituenten wie vorstehend beschrieben sind, mit der Maßgabe, dass keiner der Reste $R^7 - R^{10}$ Halogen darstellt, oder

f) Umsetzen einer Verbindung der Formel I, worin einer der Reste $R^1 - R^4$ eine Aminogruppe darstellt, mit einem C_{1-4} -Alkylsulfonylhalogen, unter Gewinnung einer Verbindung der Formel I, worin einer der Reste $R^1 - R^4$ eine C_{1-4} -Alkylsulfonylaminogruppe darstellt, oder

g) Reduzieren einer Verbindung der Formel I, worin R^5 und/oder R^6 eine Carbonylgruppe wiedergibt, unter Gewinnung der entsprechenden Hydroxyverbindung, oder

h) Oxidieren einer Verbindung der Formel I, worin X -S- wiedergibt, unter Gewinnung der entsprechenden Sulfonyl ($-SO_2-$) verbindung, oder

i) Abspalten von (a) Hydroxy- oder Aminoschutzgruppe(n), die als (a) Substituent(en) $R^1 - R^4$ vorliegen, und

j) falls erwünscht, Umwandeln der erhaltenen Verbindung der Formel I in ein pharmazeutisch verträgliches Säureadditionssalz.

16. Verwendung einer Verbindung nach einem der Ansprüche 1 - 12 zur Behandlung von Erkrankungen.

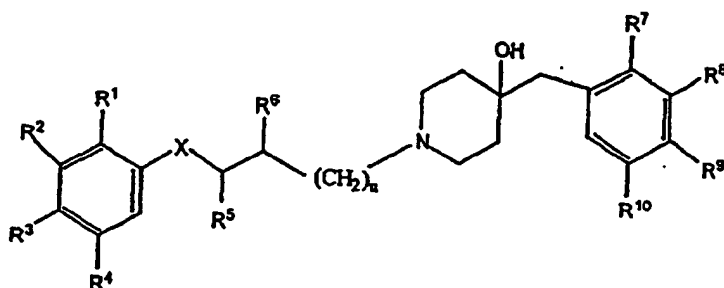
17. Verwendung einer Verbindung nach Anspruch 16 zur Behandlung von Erkrankungen, die auf therapeutischen Indikationen für NMDA-Rezeptor-Subtyp-spezifische Blocker basieren, die akute Formen von Neurodegeneration, verursacht beispielsweise durch Schlaganfall und Hirntrauma, und chronische Formen von Neurodegeneration, wie Alzheimer-Krankheit, Parkinson-Krankheit, Huntington-Krankheit, ALS (amyotrophe laterale Sklerose) und Neurodegeneration, verbunden mit bakteriellen oder viralen Infektionen, einschließen oder zur Herstellung eines Arzneimittels, das eine solche Verbindung enthält.

Revendications

1. Composé de formule

5

10



I

dans laquelle

15

X représente -O-, -NH-, -CH₂-, -CH=, -CO₂-, -CONH-, -CON(alkyle en C₁₋₄)-, -S- et -SO₂-;
 R¹ - R⁴ représentent indépendamment l'un de l'autre un atome d'hydrogène ou d'halogène ou un groupe hydroxy, (alkyle en C₁₋₄)-sulfonylamido ;
 R⁵, R⁶ représentent indépendamment l'un de l'autre un atome d'hydrogène ou un groupe alkyle en C₁₋₄, hydroxy, alcoxy en C₁₋₄ ou oxo ;
 R⁷ - R¹⁰ représentent indépendamment l'un de l'autre un atome d'hydrogène ou d'halogène ou un groupe alkyle en C₁₋₄, trifluorométhyle ou alcoxy en C₁₋₄;
 n vaut 0 ou 1 ;

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et ses sels d'addition d'acides pharmaceutiquement acceptables.

2. Composé selon la revendication 1, dans lequel X est -O-.

3. Composé selon la revendication 1 choisi dans le groupe suivant :

30

1-[2-(4-hydroxy-phénoxy)-éthyl]-4-(4-méthyl-benzyl)-pipéridin-4-ol ;
 4-(4-fluoro-benzyl)-1-[2-(4-hydroxy-phénoxy)-éthyl]pipéridin-4-ol ;
 N-(4-{2-[4-(4-méthyl-benzyl)-pipéridin-1-yl]-éthoxy}-phényl)-méthanesulfonamide ;
 N-(4-{2-[4-(4-fluoro-benzyl)-4-hydroxy-pipéridin-1-yl]-éthoxy}-phényl)-méthanesulfonamide ;
 N-(4-{2-[4-(4-chloro-benzyl)-4-hydroxy-pipéridin-1-yl]-éthoxy}-phényl)-méthanesulfonamide ;
 N-(4-{3-[4-(4-fluoro-benzyl)-4-hydroxy-pipéridin-1-yl]-propoxy}-phényl)-méthanesulfonamide ;
 1-[2-(4-hydroxy-phénoxy)-1-méthyl-éthyl]-4-(4-méthyl-benzyl)-pipéridin-4-ol.

35

4. Composé selon la revendication 1, dans lequel X est -NH-.

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5. Composé selon la revendication 4, choisi dans le groupe comprenant

le 2-(4-benzyl-4-hydroxy-pipéridin-1-yl)-N-(4-hydroxy-phényl)-acétamide et
 le 2-[4-hydroxy-4-(4-méthyl-benzyl)-pipéridin-1-yl]-N-(4-hydroxy-phényl)-acétamide.

45

6. Composé selon la revendication 1, dans lequel X est -CH₂-.

7. Composé selon la revendication 6, choisi dans le groupe suivant:

50

(RS)-4-benzyl-1-[2-hydroxy-3-(4-hydroxy-phényl)-propyl]-pipéridin-4-ol ;
 (RS)-1-[2-hydroxy-3-(4-hydroxy-phényl)-propyl]-4-(4-méthylbenzyl)-pipéridin-4-ol ;
 (RS)-4-(4-chloro-benzyl)-1-[2-hydroxy-3-(4-hydroxy-phényl)-propyl]-pipéridin-4-ol.

8. Composé selon la revendication 1, dans lequel X représente -S- ou -SO₂-.

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9. Composé selon la revendication 1, dans lequel X représente -CH=.

10. Composé selon la revendication 1, dans lequel X représente -CO₂-.

11. Composé selon la revendication 1, dans lequel X représente -CONH-.

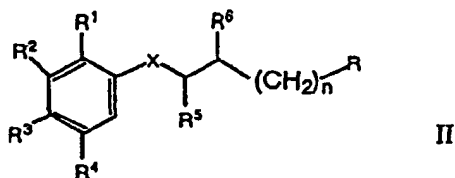
12. Composé selon la revendication 1, dans lequel X représente -CON (alkyle en C₁₋₄).

5 13. Médicament contenant un ou plusieurs composés selon l'une quelconque des revendications 1 à 12 ou un de leurs sels pharmaceutiquement acceptables et un véhicule inerte pour le traitement de maladies.

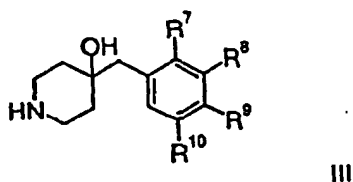
10 14. Médicament selon la revendication 13 pour le traitement des maladies basées sur les indications thérapeutiques pour les inhibiteurs spécifiques de sous-types du récepteur de NMDA, qui englobent les formes aiguës de neurodégénérescence provoquées par exemple par une attaque et un traumatisme cérébral, et les formes chroniques de neurodégénérescence telles que la maladie d'Alzheimer, la maladie de Parkinson, la chorée de Huntington, l'ALS (sclérose latérale amyotrophique) et la neurodégénérescence associée aux infections bactériennes ou virales.

15 15. Procédé de préparation d'un composé de formule I tel que défini dans la revendication 1, qui comprend

a) la réaction d'un composé de formule

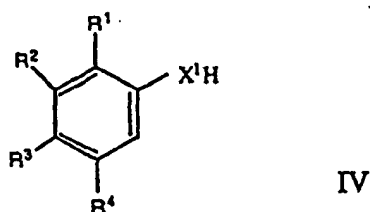


avec un composé de formule



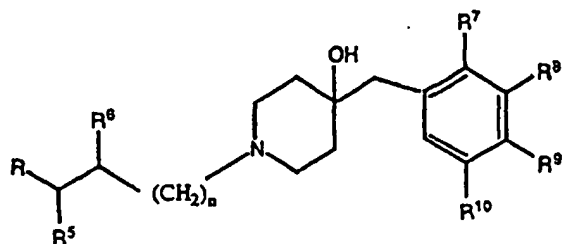
formules dans lesquelles R¹-R¹⁰ et X ont les significations données dans la revendication 1, n vaut 1, R est un groupe partant et R⁶ est un groupe oxo ou hydroxy, ou

b) la réaction d'un composé de formule



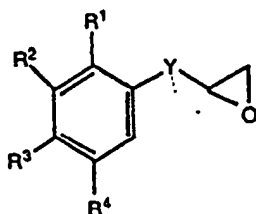
50 avec un composé de formule

55



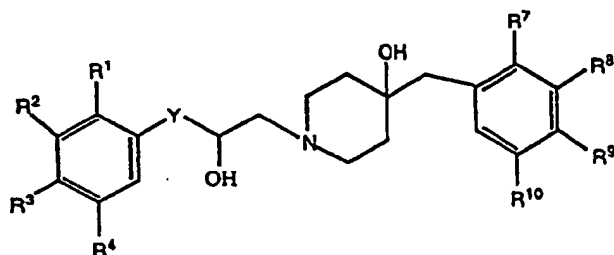
V

formules dans lesquelles $R^1 - R^{10}$ et n ont les significations données dans la revendication 1, R est tel que décrit ci-dessus et X^1 est -O-, -NH-, -N (alkyle en C_{1-4})- ou -S-, ou
c) la réaction d'un composé de formule



VI

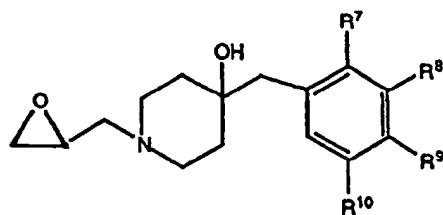
avec un composé de formule III pour obtenir un composé de formule



Ia

formules dans lesquelles $R^1 - R^4$ et $R^7 - R^{10}$ ont les significations données dans la revendication 1 et Y représente -XCH₂- ou -CH₂-, ou

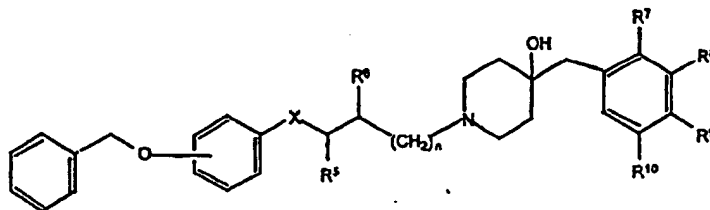
d) la réaction d'un composé de formule IV avec un composé de formule



VII

pour obtenir un composé de formule Ia, où $R^1 - R^4$ et $R^7 - R^{10}$ ont les significations données dans la revendication 1, ou

e) la débenzylation d'un composé de formule



VIII

dans laquelle les substituants sont tels que décrits ci-dessus, étant entendu qu'aucun d'entre $R^7 - R^{10}$ est un atome d'halogène, ou

f) la réaction d'un composé de formule I dans laquelle l'un d'entre $R^1 - R^4$ est un groupe amino, avec un (alkyle en C_{1-4})-sulfonyl halogène pour obtenir un composé de formule I dans laquelle l'un d'entre $R^1 - R^4$ est un groupe (alkyle en C_{1-4})-sulfonyl-amino, ou

g) la réduction d'un composé de formule I, dans laquelle R^5 et/ou R^6 représentent un groupe carbonyle pour donner le composé hydroxy correspondant, ou

h) l'oxydation d'un composé de formule I, dans laquelle X représente -S- pour donner le composé sulfonyl (-SO₂-) correspondant, ou

i) la scission d'un (de) groupe(s) hydroxy ou amino protecteurs présents comme substituant(s) $R^1 - R^4$, et

j) si on le souhaite, la conversion du composé de formule I obtenu en un sel d'addition d'acide pharmaceutiquement acceptable.

16. Utilisation d'un composé selon l'une quelconque des revendications 1 - 12 pour le traitement de maladies.

17. Utilisation d'un composé selon la revendication 16 pour le traitement des maladies basées sur les indications thérapeutiques pour les inhibiteurs spécifiques de sous-types du récepteur de NMDA, qui englobent les formes aiguës de neurodégénérescence provoquées par exemple par une attaque et un traumatisme cérébral, et les formes chroniques de neurodégénérescence telles que la maladie d'Alzheimer, la maladie de Parkinson, la chorée de Huntington, l'ALS (sclérose latérale amyotrophique) et la neurodégénérescence associée aux infections bactériennes ou virales ou pour la fabrication d'un médicament contenant un tel composé.